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SITE NAME: Gunung Mulu National Park

DATE OF INSCRIPTION: 2nd December 2000

STATE PARTY: Malaysia

CRITERIA: N (i)(ii)(iii)(iv)

DECISION OF THE WORLD HERITAGE COMMITTEE:
Excerpt from the Report of the 24th Session of the World Heritage Committee

Criteria (i), (ii), (iii) and (iv): The concentration of caves in Mulu's Melinau Formation with its geomorphic and structural characteristics is an outstanding feature which allows a greater understanding of Earth's history. The caves of Mulu are important for their classic features of underground geomorphology, demonstrating an evolutionary history of more than 1.5 million years. One of the world's finest examples of the collapse process in Karstic terrain can be also found. GMNP provides outstanding scientific opportunities to study theories on the origins of cave faunas. With its deeply-incised canyons, wild rivers, rainforest- covered mountains, spectacular limestone pinnacles, cave passages and decorations, Mulu has outstanding scenic values. GMNP also provides significant natural habitat for a wide range of plant and animal diversity both above and below ground. It is botanically- rich in species and high in endemism, including one of the richest sites in the world for palm species.

IUCN also noted the positive response received from the authorities received concerning a number of issues raised at the twenty-fourth session of the Bureau and proposed that the authorities be encouraged to review the additions to the site for their World Heritage potential when the gazetting process is completed.

The Observer of Malaysia stressed the commitment of the authorities to preserve the site.

BRIEF DESCRIPTIONS

Important both for its high biodiversity and for its karst features, Gunung Mulu National Park on the island of Borneo (State of Sarawak) is the most studied tropical karst area in the world. The 52,864ha park has 17 vegetation zones, exhibiting some 3,500 species of vascular plants. Its palm species are particularly rich, with 109 species in 20 genera noted.
The park is dominated by Gunung Mulu, a 2,377m high pinnacle karst, said to be the most cavernous mountain in the world, with at least 295km of explored caves providing a major wildlife spectacle in terms of millions of cave swiftlets and bats. The Sarawak Chamber, 600m x 415m x 80m high, is the largest known cave chamber in the world.

1.b State, Province or Region: northern Sarawak, island of Borneo

1.d Exact location: 3° 57' N, 114° 47' E

THE GUNUNG MULU NATIONAL PARK NOMINATION FOR WORLD HERITAGE LISTING

THE GUNUNG MULU NATIONAL PARK NOMINATION

FOR WORLD NATURAL HERITAGE LISTING.
SARAWAK, MALAYSIA.

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THE GUNUNG MULU NATIONAL PARK, SARAWAK, MALAYSIA, NOMINATION FOR WORLD HERITAGE LISTING.

Abstract.
The Gunung Mulu National Park was constituted in 1974 and opened to the public in 1985. It covers an area of 52,864 hectares (528 square kilometers) and is situated between the headwaters of the Tutuh river, a tributary of the Baram river, and the Medalam river a tributary of the Limbang river. It thus spans the watershed between the Fourth and Fifth administrative Divisions of Sarawak with the northwest border lying along the international boundary with Brunei Darussalam.

It meets all four of the criteria for Natural World Heritage Status. The park represents an outstanding example of major changes in the earth's history. Three major Tertiary rock formations are evident. The Mulu Formation of Paleocene and Eocene shale's and sandstone's rising to 2,377 metres at the summit of Gunung Mulu. The 1.5 kilometer thick Melinau Limestone formation of Upper Eocene, Oligocene and Lower Miocene, rising to 1,682 metres at Gunung Api, and the Miocene Setap Shale Formation outcropping as a gentle line of hills to the west. Major uplift occurred during the late Pliocene to Pleistocene. This is well represented in the 295 kilometers of explored caves as a series of major cave levels. The caves are some of the largest to be found in the world with fine examples of tropical river caves, flood incuts, vadose, phreatic and paragenetic profiles and exhibiting fine examples of all types of speleothems. The surface and underground geomorphology and hydrology provide significant information on the tectonic and climatic evolution of Borneo. The sequence of terrestrial alluvial deposits provide an important record of glacial – interglacial cycles, while the cave clarst deposits have been dated by Paleomagnetic dating techniques from all levels of cave development. From base level at 28 meters to over 300 meters a sequence of reversals of the earth's magnetic field revealed the caves to be at least 2 to 3 million years old.
Uplift rates have been calculated at 19 centimeters per 1,000 years.

The park also fulfils the criteria of ongoing ecological and biological processes. Seventeen vegetation zones have been identified along with their diverse associated fauna, with 3,500 species of plants, 1,700 mosses and liverworts and over 4,000 species of fungi. 20,000 species of invertebrates, 81 species of mammals, 270 species of birds, 55 species of reptiles, 76 species of amphibians and 48 species of fish have been identified. This is only a small proportion of the total estimated species. The cave fauna including many troglobitic species is also prolific with over 200 species recorded.

The criteria for significant natural habitats for in-situ conservation are also fulfilled.
Deer Cave alone contains one of the largest colonies in the world of free tailed bats, Chaerephon plicata at over 3 million and the largest number of different species of bats to be found in one cave at 12 species. Several million cave Swiftlets, Aerodramus sp have been recorded from one cave system, the largest colony in the world. Many of the fauna species are endemic with 41 on the endangered species list. The park supports one of the richest assemblages of flora to be found in any area of comparable size.

The Gunung Mulu National Park is also an area of exceptional natural beauty, with striking primary forest, karst terrain, mountains, waterfalls and the largest caves on earth.

Sarawak Chamber, which can be visited by adventure minded visitors, is the largest cave chamber in the world at 600 metres in length by 415 meters wide and 80 meters high. With a volume of 12 million cubic meters and an unsupported roof span of 300 meters, this chamber dwarfs any other large chamber so far discovered. Deer Cave at 120 to 150 meters in diameter is the largest cave passage in the world known at the present time. The Clearwater Cave System still holds the world record as the longest cave in Asia at 110 kilometers of mapped and explored passages.

World Heritage status will provide due recognition and invaluable support to the Sarawak State Government and the Government of Malaysia to ensure the continuing management and protection of this great natural resource.

David William Gill, Karst Management Unit, National Parks and Wildlife Division, Forest Department, Sarawak, Malaysia.

THE GUNUNG MULU NATIONAL PARK NOMINATION FOR WORLD HERITAGE LISTING, 1999.

1.	**NAME OF THE COUNTRY.**	Sarawak, Malaysia.
2.	**LIST DRAWN BY.**	National Parks and Wildlife Division, Forest Department, Sarawak.
3.	**DATE.**	1/5/99.
4.	**NAME OF THE PROPERTY.**	The Gunung Mulu National Park.
5.	**GEOGRAPHICAL LOCATION.**	(Refer to Figure 1).

The present boundary extends between 3 degrees, 57 minutes to 4 degrees, 15 minutes of northern geographical latitude and from 114 degrees, 47 minutes to 115 degrees of eastern geographical longitude. The park is situated on the island of Borneo in the territory of northern Sarawak, Malaysia approximately 110 kilometres from the town of Miri.

It lies between the headwaters of the Tutuh river, a tributary of the Baram river, within the Fourth administrative Division of Sarawak, and the Medalam river, which is a tributary of the Limbang river within the Fifth Division. It thus spans the boundary, formed by a watershed, between the two administrative Divisions. More than two-thirds of the area of the Park falls within the Fourth Division. The north-west boundary of the Park lies along the international boundary with Brunei Darussalam.

Access is by boat along the Baram and Tutuh Rivers or by air from Miri, Limbang and Brunei Darrusalam. There are two entry points, the Park Headquarters situated on the southern boundary on the true left bank of the Melinau River, a tributary of the Tutuh River and the Mentawai Ranger Station on the northern boundary on the true left bank of the Medalam River, a tributary of the Limbang River.

6. DESCRIPTION.

6.1. GENERAL. (Refer to Figure 2).

The Gunung Mulu National Park has an area of 52,864 hectares (528 square kilometres), ranging in altitude from 28 metres to 2,377 metres above sea level. The park contains steep escarpments and ridges, karst towers, caves, rivers and their associated terraces and floodplains.

Vegetation consists of primary tropical rain forest including a diverse range of forest types, with a high seasonal annual rainfall ranging from 4000 mm to 5000 mm.

The boundaries are marked and for the most part follow rivers. There are short sections of cut boundaries to the south-west, east and north-west. Part of the north-west boundary is the international border with the State of Brunei.

Three extensions to the Gunung Mulu National Park have been proposed. (Refer to Figure 3)

6.1.1. The Gunung Buda National Park.

The Medalam extension to the north of the park has been proposed. This is a part of the Medalam Protected Forest. Initial gazettment of intent to constitute a new National

Park, The Gunung Buda National Park was published in the Sarawak Government Gazette, 20th August 1998. (Refer to Appendix 1). The total area is approximately 6,235 hectares, and further extensions have been proposed in order to protect the complete catchment of the Medalam River to the east, a tributary of the Limbang River.

The Gunung Buda National Park extension covers all the northern Melinau Limestones and its associated caves. Sixty kilometres of cave passages have been partly explored and mapped by the Sarawak Forest Department and Speleological expeditions from the United States of America. (Hacker, 1995). (Refer to Table 1).

6.1.2. The Ubung extension.

This area of 16,177 hectares has been proposed to protect the catchment of the Ubung River, a tributary of the Tutuh River. The Ubung River marks the boundary on the east side of the park.

6.1.3. The Lutut extension.

This region has also been proposed in order to protect the catchment of the Lutut River, a tributary of the Melinau River. Again this river marks the boundary on the west side of the park to the Brunei Darrusalam border.

6.2. GEOLOGY and GEOMORPHOLOGY. (Refer to figure 5).

Three major Tertiary rock formations are evident. (Waltham and Webb, 1982; Osmaston and Sweeting, 1982).

6.2.1. The Mulu Formation.

In order, Palaeocene and Eocene shale's and sandstone's comprise the Mulu Formation; these outcrop to the east as the summit of Gunung Mulu, reaching an altitude of 2,377 metres.

6.2.2. The Melinau Limestone Formation.

The limestone's of Upper Eocene, Oligocene and Lower Miocene ages, outcrop as a spectacular line of karst hills up to 1500 metres in thickness and reach a maximum altitude of 1,682 metres at the summit of Gunung Api.

The limestone formation has been dissected by deeply incised gorges dividing the limestone's into four distinct blocks. From south to north, the Southern Hills have been separated from Gunung Api by the Melinau Paku valley. The spectacular Melinau Gorge divides Gunung Api from Gunung Benarat, while the Medalam Gorge divides Gunung Benarat from Gunung Buda.

The limestone's are pure, massively bedded, dipping 80 degrees to the north west while fault and joints run north-easterly. The upper surface of the limestone massifs is spectacular and extremely rugged with pinnacle and arete morphology, deep gullies and cliffs. There is a very strong control of jointing on these landforms.

6.2.3. The Setap Shales.

The Miocene Setap Shale Formation outcrops as a gentle line of hills to the west. Between the limestone outcrop and the Setap Shale's is a broad alluvial plain overlying the limestone's, with Pleistocene terraces covered in Karangas forest.

6.2.4. Tectonics.

Major uplift occurred during the late Pliocene to Pleistocene, 2 to 5 million years before present. This uplift is reflected in the wide range of cave passage levels in the karst. The area is tectonically stable today.

6.3. THE CAVES. (Refer to figure 6, 7 and Table 2).

Over one hundred individual caves have been explored with a total of 295 kilometres of mapped passages at various levels, from 28 metres to 600 metres above sea level. (Brook et al, 1982).

The caves are some of the largest to be found in the world, with 40 metre by 100 metre diameter strike orientated passages and fine examples of all types of cave formations or speleothems. They are the finest examples of tropical river caves known, with well developed flood incuts, extensive clastic sediment deposits and circular or elliptical tubes linking different cave levels.

The remarkable size of the Gunung Mulu caves can be attributed to the massively bedded limestone's. The wildly spaced bedding and joints has concentrated the solutional processes along one single bed, joint or fault resulting in single large cave passages rather than many smaller ones.

6.3.1. Exploration.

The karst areas and caves are by no means fully explored. Exploration and mapping of the caves is carried out on a yearly basis by combined expeditions from the Forest Department and foreign groups. The caves of the Gunung Mulu National Park have now become world famous having been systematically explored since the first expedition in 1978. (Refer to Appendix 2).

6.3.2. Deer Cave.

Deer Cave is the world's largest natural cave passage, measuring 120 to 150 metres in diameter. This easily accessible cave is perhaps the finest example of a large tropical river cave and has high educational value.

6.3.3. Sarawak Chamber.

Gua Nasib Bagus, (Good Luck Cave) contains "Sarawak Chamber", the worlds largest natural single chamber within a cave. The chamber measures 600 metres long by 415 metres wide and 80 metres high, with a floor area of 162,700 square metres and a volume of 12 million cubic metres, dwarfing any other chamber in the world so far discovered. The maximum unsupported roof span is 300 metres.

The role of faults in the evolution of the chamber are easily seen with strong lighting. (Gilli, 1993).

6.3.4. Clearwater Cave System.

The "Clearwater Cave System" is presently 108 kilometres in length, the longest cave so far discovered in Asia and the eleventh longest cave system in the world at the present time, 1999. Exploration is not yet complete.

It displays outstanding passages developed at many levels, due to the complex alluvial history of the Melinau River and its tributaries. Dye tracing from the Melinau

Gorge proved a connection through to the Clearwater Cave Resurgence, a distance of 12 kilometres.

Clearwater Cave and Green Cave contain the largest examples of photo-karst to be found in the world, pinnacles close to the entrances pointing towards the light, the result of cyano-bacterial growth. Clearwater Cave also contains the world's longest wind blown stalactite at one metre plus. Stromatolites, (stalactites pointing towards the light caused by the effect of blue green algae and calcium carbonate deposition) are also common at all the cave entrances.

6.3.5. Caves open to visitors.

Four caves have been developed with pathways and lighting for visitors, the visitors being accompanied by trained National Park or Tour Guides. A further seven cave trails have been opened for Adventure Caving activities, again all visitors are required to be well equipped and are accompanied by trained National Park guides.

6.4. THE VEGETATION. (Refer to Figure 4 and Appendix 3).

The wide range of soil types and altitude account for a diverse range of vegetation, all inland vegetation formations being representative, the only exception being those on igneous soil types.

Over 1,500 species of flowering plants have so far been identified and a total of 3,500 plant species listed. Identification of Moses and Liverwort amounts to 1,700 species with 4,000 species of fungi. This is only a fraction of the estimated total.

Seventeen vegetation zones have been identified. (Anderson and Chai, 1982).

6.4.1. Gunung Mulu massive.

Multi - storied mixed dipterocarp lowland forest can be found up to an altitude of 800 metres; 284 species of trees were recorded in three plots totalling 1.2 ha. This forest is amongst the most diverse in Malaysia.

Between 800 to 1,200 metres, lower montane forest vegetation predominates, again rich in species.

Upper montane forest (tall facies) from 1,200 to 1,900 metres marks the lower limits of mossy forest with 155 species of trees identified in five plots totalling 0.365 ha. Upper montane forest (short facies) between 1,600 and 2,177 metres comprises a dense mass of stunted trees with four species of *Rhododendron* and many species of orchids and pitcher plants, *Nepenthes muluensis* being endemic to the Gunung Mulu National Park.

The upper montane forest (summit facies), rises to 2177 m with four species of terrestrial orchids.

6.4.2. Melinau limestone.

Limestone scree forest; limestone cliff vegetation; lowland limestone forest up to 800 metres; lower montane limestone forest from 800 to 1,200 metres; upper montane limestone forest rising above 1,200 metres and limestone cave vegetation all contain numerous calcicolous species that are endemic. This includes 12 species of One Leaf Plant, *Monophyllaea sp.*, seven of which are endemic to the Gunung Mulu National Park.

The limestone flora is one of the most diverse and best preserved in Southeast Asia.

6.4.3. Alluvial Plain.

The lowland alluvial forest; tropical heath forest; peat swamp and riparian forest all contain numerous endemic species, being the most complex vegetation formation in the park. Emergents attain a height of forty metres with maximum girths of 250 cm.
The Setap Shale's in the Mentawai drainage exhibit lowland mixed dipterocarp and Karangas forest; these formations are rich in palm flora.

6.5. THE FAUNA.

The Park contains a diverse range of species that include the following:

6.5.1. The mammals. (Refer to Appendix 4).

A total of 81 species of mammals, (Cranbrook, 1982a), which includes 7 species of insectivores; 1 species of colugos, *Cynocephalus variegatus*, the Flying Lemur; 1 species of Pholidota, *Manis javanica*, the Pangolin; 28 species of bats, (Hall, 1996) which includes the only specimen of *Coelops robinsoni* found in Borneo; 8 species of primates; 22 species of rodents; 10 species of carnivores and 4 species of cloven - hoofed ungulates.

6.5.2. The birds. (Refer to Appendix 5).

A total of 270 species of birds have been recorded, (Cranbrook, 1982b).
10 non breeding migrants are recorded. Of the 29 resident Borneo bird species, 26 have been recorded within the park area. The eagles, hawks and falcons are very well represented with 13 recorded species. The low – lying alluvial forest supports the greatest number of bird species.

6.5.3. The reptiles. (Refer to Appendix 6).

55 species of reptiles, (Dring and Kiew, 1982a), which includes the rare Cave Gecko, *Cyrtodactylus caverniclus*, and the Striped Cave Racer Snake, *Elaphe taeniura*. 25 species of snakes are recorded which represents only 15% of the total known Borneo species. Further research will no doubt lengthen this list.

6.5.4. The amphibians. (Refer to Appendix 7).

A total of 76 species of amphibians have been recorded. (Dring and Kiew, 1982b). Most diverse are the true frogs, genus Rana, 14 species having been recorded, and the tree frogs, *Rhacophorus,* 10 species.

6.5.5. The fish. (Refer to Appendix 8).

48 species of fish, (Cramphorn, 1982) have also been recorded. 9 species of cavefish have been identified including the flying fish, *Nematabramis everetti,* and the catfish, *Silurus furnessi.*

6.5.6. The invertebrates.

Invertebrates have been estimated at 20,000, including 281 species of butterflies, (Refer to Appendix 9), recorded by Holloway (1984). The largest group of invertebrates being *Coleoptera*, 8,000 species and *Lepidoptera,* 3,000 species. The identified species of invertebrates can only be considered as a small percentage of the total number.

6.5.7. The cave fauna. (Refer to Appendix 10).

The cave fauna is prolific and diverse with many endemic species (Gill, 1998b). Chapman (1984) recorded over 200 species, classifying them into five separate groups.

1: (AC). Accidental stray epigean species not dependent on cave habitats.

2: (VI). Visitors, epigean species that enter caves periodically within the daylight zone to feed.

3: (TX). Trogloxenes, species that sometimes shelter and breed in caves within the daylight zone, but feed outside.

4: (TP). Troglophiles, species that enter caves beyond the daylight zone and generally complete their life cycle in hypogean as well as epigean habitats.

5: (TB). Troglobites, species that complete their entire life cycle in hypogean habitats only.

6.6. COMPARATIVE STUDIES FROM MALAYSIAN NATIONAL PARKS.

Studies of Malaysian National Parks indicate that the Gunung Mulu National Park contains a very high diversity of both flora and fauna species in its relatively small area. (Refer to Table 3).

Of all the present Malaysian National Parks only the significantly larger totally protected areas of Kinabalu National Park in Sabah and Taman Negara National Park in West Malaysia have an equivalent diversity. The altitudinal range of Kinabalu and the diversity of environments of Taman Negara account for the high diversity, so also does the remarkable diversity of habitats in Gunung Mulu.
As the biological research is still in its infancy no doubt many other species will be found in the less accessible areas of the Gunung Mulu National Park in the future.

7. JUSTIFICATION OF OUTSTANDING UNIVERSAL VALUES. NATURAL CRITERIA MET FOR INCLUSION OF PROPERTIES IN THE WORLD HERITAGE LIST.

7.1. Criterion (I).

The Gunung Mulu National Park fulfils the criterion of an outstanding example representing major stages of the earth's history.

7.1.1. The geology. (Refer to Figure 5)

The geology of the park has been the focus of much scientific study, (Liechti et al, 1960; Wilford, 1961, 1964; Webb, 1982), revealing 3 main lithologies

(a) The Mulu Formation.

The 5 - 6 km thick slightly metamorphosed sandstone and shale of the Mulu Formation, of the Late Cretaceous - Eocene period.

(b) The Melinau Limestone.

The overlying shallow marine deposits of the Melinau Limestone of the Upper Eocene - Lower Miocene period.

(c) The Setap Shale's.

The Setap Shale's of the Middle Oligocene - Early Miocene period.

These Tertiary rocks laid down in an outer arc basin experienced compression resulting in orogenic uplift during the Mid - Miocene period. These massive formations are well exposed and present an important biostratigraphic record for understanding the geological evolution, uplift history and long term environmental changes on the Sunda Shelf and surrounding lands.

7.1.2. The geomorphology and hydrology.

The surface geomorphology and hydrology has been studied extensively (Day, 1980; Rose, 1982, 1984; Osmaston and Sweeting, 1982, Walsh, 1983a, 1983b, Farrant et al. 1995). The Mulu karst has provided very significant information on the tectonic and climatic evolution of the island of Borneo and the humid tropics in general.

7.1.2.1. The alluvials.

Large alluvial fans are evident emerging from the Melinau Gorge and the Melinau Paku Valley, with remnants of early Pleistocene fans preserved as terrace gravels. Fan aggradation is due to climatic control rather than tectonic influences. Increased rainfall during interglacials produced higher sediment loads, while relatively drier glacials with less sediment transport leading to incision of the fans.

This sequence of alluvial deposits thus provides an important record of glacial – interglacial cycles with which to interpret landform evolution. It is the best preserved sequence in Southeast Asia.

At the south end of the park aggradation is also occurring on the Tutuh River, causing backing up of the Melinau River with increased sediment deposition.

The present pattern of relief indicates that the Melinau and Medalam Rivers flowed to the north west along the line of the Belait River, the Melinau later to be diverted south towards the Tutuh River via stream capture and the Medalam north to the Limbang River.

7.1.2.2. Future predictions.

Predictions for the future indicate periods of diversion of the Melinau drainage system from the Melinau Gorge area towards the Medalam and Limbang Rivers due to rapid sediment deposition.

The alluvial sequences and drainage patterns are thus still evolving, and provide a unique opportunity to study the dynamics of major tropical rivers in relatively undisturbed natural systems. This is especially relevant to enhanced understanding of the effects of increased sediment load, base level changes and climatic variability under conditions of global warming.

7.1.2.3. The karst.

The karst mountains exhibit classical tropical karst features, pockmarked with dolines, closed depressions, valleys and caves. The scale of the karst features is impressive and a large variety is present in a relatively small area.

In the southern hills, "The Garden of Eden" is the world's largest collapsed doline, being over one kilometre in diameter. (Waltham et al. 1993).

Hidden Valley on the east side of Gunung Api is a deeply incised closed valley with a misfit stream sinking in its bed. Dye tracing proved a connection through to Cobra and Good Luck Caves and the Melinau Paku Valley.

The Melinau, Melinau Paku and Medalam Rivers have truncated the limestones, forming deeply incised gorges with towering 300 metre high cliffs and remnants of high level caves.

Some of the worlds finest examples of pinnacle karst can be found on the karst mountains of Gunung Benarat and Api.

This rich diversity of karst landforms is of outstanding scientific and educational value, as much of it is relatively accessible to visitors.

7.1.3. The Caves. (Refer to Figures 6, 7 and Table 2)

The caves are unique, not only for their outstanding size but their representation of major stages in the earth's history.

Five major levels of development can be identified all aligned along the strike of the beds, approximately running north – south. North – south joints and faults predominates. The clay and gravel sedimentation at all levels is of particular significance. Little re-invasion from surface streams has taken place enabling the clarst deposits to be studied and dated.

The prolific cave fauna has also been extensively studied enabling benchmark data to be correlated for other cave sites in Southeast Asia.

7.1.3.1. Cave Geomorphology.

The cave sediment deposits are still in situ at all altitude levels, affording the opportunity for important scientific investigations of climatic change. (Farrant, 1995). These clays and gravel's are therefore not subject to normal surface erosion processes but have been preserved in situ for millennia. Paleomagnetic dating of these deposits has revealed a rapid uplift rate of the mountains of 19cm per 1,000 years. Reversal of the earth's magnetic field recorded in the sediments at 1.8 million years before present indicates that the caves are at least 2 million years old, possibly as much as 3 million years.

Notches in the walls of the caves at various levels can be correlated with interglacial periods.

The caves are predominately phreatic in origin but exhibit both vadose, phreatic and paragenetic profiles with some of the world's finest examples of phreatic pendants. The caves are therefore of outstanding significance in recording major changes in earth history.

7.1.3.2. Archaeological cave sites.

The artefacts and human remains excavated from Wind Cave by the Sarawak Museum, date from 3000 to 500 years before present. (Datan and Bellwood, 1990). The cave was never used for habitation as no hearths or charcoal deposits were found. The method of burial is identical to that found at Batu Niah, 160 kilometres to the north east, while the grave goods consisting of pottery and glass beads also resemble the artefacts discovered at the Niah site.

Similar pottery has also been noted from approximately the same period (c2000 BP) from the Admiralty Islands of Papua New Guinea, 3,800 kilometres to the east.

Iron knives were also found at Wind Cave, from a later period. The glass beads were identical to those excavated from Gua Sireh, Serian region, near Kuching, 700 kilometres to the southwest.

Research is by no means complete and the area is protected from human disturbance. Many other caves in the park were used as ancient burial sites by the Tring indigenous group, the original inhabitants of the region, with in situ examples of Chinese jars and human remains; these have been left undisturbed.

7.1.3.3. The cave fauna. (Refer to Appendix 10).

The extensive studies carried out on the cave invertebrates determined that many were living fossils possibly dating as far back as the Cretaceous period. Some of the closest relatives are found in Asia, Australia and South America, complimenting the theories of migration and continental drift.

7.2. Criterion (II).

The Gunung Mulu National Park fulfils the criterion of an outstanding example representing ongoing ecological and biological processes in the evolution of terrestrial habitats.

7.2.1 The flora. (Refer to Appendix 3).

The range of soil, rock and altitude zones has ensured a high diversity of the flora in the seventeen vegetation types represented. On average 780 different species of trees can be found in a typical 10-hectare plot.

The park is one of the richest sites in the world for palms; 111 species have so far been identified. A total of 3,500 species of plants have been identified by numerous botanists, which include 1,326 *dicotyledons;* 115 *Dipterocarpacea* and 63 *Lauraceae.* This includes 1,500 species of flowering plants.

1,700 mosses and liverworts have been catalogued along with 4,000 species of fungi. The varied and diverse fauna also complements the diversity of vegetation formations.

7.2.2. The cave invertebrates. (Refer to Appendix 10).

The detailed work by Chapman, (1980), (1982), and (1984) concentrated on the diverse invertebrates from 15 separate cave sites within the Gunung Mulu National Park.

7.2.2.1. Habitats.

The community food ecology was studied, with four identifiable habitats.

A: (SCAT habitats), damp scattered swift guano.
B: (SHALLOW habitat), flood sediment in low level caves.
C: (SWIFTLET habitat), Swiftlet guano.
D: (BAT habitat), bat guano.

7.2.2.2. Invertebrate list.

The invertebrate list included; 1 – Accidental, (AC); 1 – Visitor, (VI);
5 - Trogloxenes, (TX); 79 - Troglophiles, (TP) and 27 - Troglobites, (TB).
A further 17 - Insecta *Diptera* were collected but only identified to family level, classification unknown. A further 11 - various species were collected, classification unknown.

The list included, 2 - (TP) Mollusca. 18 - Crustacea, which included 4 - crabs, one of them being a Troglobite crab, the first such discovery outside the Americas, *Cerberusa caeca.* 7 - millipedes, Diplopoda. 4 - species of Chilopoda centipedes. 2 - Troglobite

Arachinda scorpions. 3 - Pseudoscorpionida. 18 - cave spiders. 6 - species of Arachnida, mites. 3 - species of cave cockroach, *Trogloblattella chapmani,* being a new species, the only other *Trogloblattella,* is from Australia. 4 - cave crickets. 17 - beetles and 15 - ants, to name but a few.

7.2.2.3. Diversity.

The cave adapted invertebrate species have not been found to be as diverse as that found in some of the other major cave areas of South East Asia. However the importance of the Mulu communities lies in the depth of research already carried out. This research provides for a very important insight into the ecology of cave fauna in the tropics.

The greatest numbers and diversity was recorded from Deer Cave, 5 - species being endemic. Some species are confined to specific areas within the cave associated with different colonies of bats.

Arthropoda, Crustacea proved to be the largest family group of Troglobites.
Some of the identified species have been recorded from the caves of the Bau region, Sarawak and from Batu Niah, but little work has been carried out on the distribution from other caves within the state.

7.2.2.4. Evolution of troglobitism.

Various research workers have discussed the evolution of troglobitism.

Barr (1968) expressed the traditional view of the evolution of cave adapted fauna. This rested upon the isolation of fauna due to climatic change or other catastrophic events. The movement into caves as refugia, with their special environments of low energy availability would lead to a subsequent adaptation for efficiency in metabolism.

The recent research by Howarth (1981) and others on the rich and diverse cave adapted communities in tropical regions led to the conclusion that the adaptive shift of native fauna to troglobite was due to a degree of pre-adaptation, species that were suited to the higher carbon dioxide levels and humidity found in caves.

Either one of these theoretical positions may appear to best explain faunal patterns at specific sites and both may operate at the same site.

It is therefore possible that tectonic movement in the East Asian region may have provided for a degree of isolation and hence the use of caves as refugia, while pre-adaptation may have brought other species to the cave community.

The cave fauna of the Gunung Mulu National Park can potentially throw light upon this very complex evolutionary processes.

The caves of the Gunung Mulu National Park are relatively unimpacted and so provide a very important benchmark against which to assess the cave fauna from other cave areas.

7.2.3. Summary.

In summary the assemblage of plants and animals shows very high endemism and biodiversity in a relatively unaltered setting. Gunung Mulu National Park is therefore of outstanding natural value for baseline studies of ecosystem processes in the humid tropics. The combination of alluvial, sandstone and limestone ecosystems is unique in Southeast

Asia and provides opportunities to understand long-term ecosystem dynamics, landscape ecology and the impacts of visitors on tropical protected areas.

7.3. Criterion (III).

The park also fulfils the criterion of an area of exceptional natural beauty.

Gunung Mulu, the second highest mountain in Sarawak, is complemented by the karst mountains and gorges and the alluvial plain and karangas terraces to the west. The Terikan River hot springs, waterfalls of the Melinau Paku Valley, and the caves are outstanding natural phenomena.

The combination of rainforests, rugged mountains and large caves provides excellent opportunities for ecotourism and invoke awe and respect amongst visitors. The park is relatively undisturbed and provides exceptional opportunities for passive recreation such as hiking, climbing, caving, birdwatching and wildlife viewing.

7.3.1. The caves.

The caves contain some of the finest examples of passages and speleothems, while Deer Cave and Sarawak Chamber are outstanding for their sheer size.

Guided adventure caving expeditions are arranged for physically fit visitors to the world's largest chamber, Sarawak Chamber in Gua Nasib Bagus and other caves in the park.

7.3.2. Guided treks.

Guided treks through the rain forest with a Penan guide are presently in the development stage. Training programmes especially English language courses for the Penan guides are being implemented. This will give an enhanced experience for the visitor as the Penan where originally nomadic in the region. Their knowledge of medicinal plants, survival in the forest environment, their beliefs in the forest spirits and culture will greatly enhance the general visitor experience.

7.4. Criterion (IV).

The park also contains significant natural habitats for in - situ conservation.

7.4.1. The fauna. (Refer to Appendix 4, 5,6,7,8,9 and 10)).

The mammals include 2 species of Borneo endemic squirrels, the tufted ground squirrel, *Rheithrosciurus macrotis* and the plain pigmy squirrel, *Exilisciurus exilis*.

The tiniest mammal in the world the Savi's pigmy shrew, *Suncus etruscus* weighing only 2 grams can be found in profusion. The round - eared tube nosed bat *Coelops robinsoni* and the tailess horse shoe bat *Murina cyclotis* have not been previously recorded from Borneo. An unidentified tree mouse was seen at 1750 meters altitude, again many of this group are endemic to Borneo. Small unidentified cave troglobitic mammals have been seen in the remote regions of Clearwater Cave, but so far have avoided capture.

Many of the invertebrates including the cave fauna are endemic to the park. The Lepidoptera are particularly well represented with 80 percent of the Borneo species recorded. Endemics include *Celastrina sp* close to *C. lingga* and *Xpthima hanburyi.*

Some of the recorded fish species are also endemic, no doubt further research on the aquatic and terrestrial fauna will reveal many more. (Anderson et al, 1982).

Exotic species are banned from the park area and wildlife surveys and monitoring programs have been introduced, carried out by the park staff, but monitoring programs need to be increased in regularity. Wildlife monitoring training programs have recently been introduced in line with the Sarawak Wildlife Master Plan and the 1998 Wildlife Ordinance.

7.4.1.1. The cave fauna. (Refer to Appendix 10).

The caves contain a diverse range of troglobitic species, many as yet unidentified and large colonies of bats and swiftlets. Many of these troglobitic species are endemic. The research on cave fauna is by no means complete.

7.4.1.2. The bats. (Refer to Appendix 4).

Deer Cave contains one of the worlds largest colonies of free tailed bats, the wrinkle – lipped bat, *Chaerephon plicata,* numbering approximately three million. This cave also contains the largest number in the world of different species of bats to be found in one single cave, 12 different species having been identified to date. The research on bats is by no means complete and the list of 28 species will be added to in due course. The Gunung Mulu National Park has the highest recorded number of different species of bats in South East Asia.

All bat species have now been placed on the protected list for Sarawak's fauna. The insectivore bats play an important role in natural control of insect populations, while the fruit bats are major seed dispersal agents contributing to the natural generation of forests and re-generation of logged over forests. This is an important factor in the regeneration of Sarawak's forests considering the states selective logging policy and its policy of sustainability. The nectar bats play an equally important role as major pollinators. Two of the bat species have not been seen elsewhere in Borneo, the lesser tailess round leaf and the orange tube nosed. The rare montane species, the grey fruit bat is also found.

The evening flight of between 2 to 3 million bats from the huge portals of Deer Cave is one of the world's great natural wonders.

7.4.1.3. The cave swiftlets. (Refer to Appendix 5).

The cave swiftlet, *Aerodramus sp.* populations are also very high, several million cave swiftlets have been recorded from one single cave system within the park. The exact figure is unknown as the cave is situated in one of the most inaccessible areas of the park. Again the swiftlets are major controllers of insect populations. This colony of cave swiftlet, *Aerodramus sp.* is the largest known colony in the world. As the caves and feeding grounds are protected from human disturbance the survival of these large populations seems assured.

The early morning exudes of several million cave swiftlets from a cave entrance 40 metres in diameter which is continuos for several hours is again one of the worlds great natural spectacles.

7.4.1.4. The birds. (Refer to Appendix 5).

All 8 of Borneo's hornbill species are represented along with all the 6 Borneo species of trogons. 21 species of bulbuls and 16 species of cuckoos have been identified including the very rare ground cuckoo. 5 malechas have been identified and the very rare bamboo munia, which is endemic to Borneo, this species has only been found in Mulu and Kinabalu.

7.4.1.5. The Reptiles. (Refer to Appendix 6).

The reptiles are particularly well represented with 4 species of flying lizards and 7 gecko's, 2 of which are endemic. The research on the reptilian species is by no means complete.

7.4.1.6. The Frogs. (Refer to Appendix 7).

Two thirds of all known Borneo species of amphibians can be found including Wallace's flying frog and 6 of the montane species only found in Mulu and Kinabalu. The *Philautus sp.* only breeds in the fluid of the pitcher plant while the Rana macradon group are the largest known frogs in the world.

14 of the species identified have not been recorded previously from Borneo and several are endemic. Further research on the amphibians would provide valuable information on the ecology of isolating mechanisms.

7.4.1.7. Threatened Species.

The IUCN Red List of Threatened Species lists the following as Endangered (EN), Vulnerable (VU), Near Threatened (NR/nt) and Data Deficient (DD).

	Endangered (EN)	Vulnerable (VU)	Near Threatened (NR.nt)	Date deficient (DD)
Mammals		4	10	1
Birds	1	6	13	3
Reptiles		1	1	
Fish				1
Total	1	11	24	5

Total 41 species.

7.4.2. The flora. (Refer to Figure 4 and Appendix 3).

Generally the Tropical rain forest that clothes the whole island of Borneo contains one of the richest floras in the world. There is some evidence to indicate that the northern part of the island, comprising the Malaysian states of Sarawak and Sabah, as well as Brunei and the Indonesian province of Kalimantan Barat, is especially rich in species. This may be in part due to evolutionary and plant geographical trends, but is also related to the diversity of habitats consequent of the variation in geology and land types.

Within the Gunung Mulu National Park, the remarkable diversity of vegetation types supports perhaps one of the richest assemblages of species to be found in any area of comparable size. Present knowledge of the flora of the Park is nevertheless incomplete, and much further research, in particular intensive collecting by specialists, is required to obtain a fuller understanding.

The park is known to contain many endemic species including the One Leaf Plant, *Monophilia pendula,* seen only at the entrance to Clearwater Cave. The Pitcher Plant, *Nepenthes muluenis* and the Palm, *Salacca rupicola.* The park contains a remarkable number of Pteridophytes, spore-producing plants, the total number of species identified to date amounts to 442, for the most part ferns. The Gunung Mulu National Park is also one of the richest sites in the world for Palm species, 111 having so far been identified.

Many of the palms are endemic to the park, including *Iguanura melinauensis* and *Licuala lanata* from the alluvium forest. The limestone forest support a number of endemic palms including *Calamus neilsonii* and *Salacca rupicola* while the setap shale forest types support the endemics *Salacca magnifica* and *Areca abdulrahmanii.* The endemic *Pognotium divaricatum* can be found in the karangas forest.

Much of the limestone flora is unique to the park as the limestone mountains are the highest between north Sumatra and New Guinea. 7 out of the 12 recorded Monophyllaea species are endemic as are 3 Cyrtandra from the same family. The very rare *Saprophyte, Cotylanthera tenuis* can also be found on Gunung Api.

Of the 12 recorded pitcher plants, *Nepenthus muluensis* is endemic to Mulu and the very rare *N. veitchii* can also be found.

Many of the previously Kinabalu National Park endemic species of fern and bryophyte have now been identified in the Gunung Mulu National Park. Limestone endemic ferns include *Adiantum hosei* and *Pneumatopteris* but only small areas of the park has so far been covered. Further research will reveal more.

The mosses endemic to the park are many including *Stereodontopsis flagellifera, Coryphopteria andersonii, Hypnodendron* vitiense and from the upper montane forest *Hypnodendron beccarii* and *Rhizogonium pseudo-distichum.* The very rare bogmoss, *Sphagnum perichaetiale* can be found in the rain gullies in the high forest. Numerous endemic lichens have also been identified.

The preliminary list of Pteridophytes included one family of Thelypteridaceae, out of 50 of the taxa, 15 are described as new to science.

The fungi identified included many new species, genera and one new family. (Anderson et al, 1982).

8. ASSURANCES OF AUTHENTICITY OR INTEGRITY.

8.1. Proclamation. (Refer to Appendix 11).

The park was fully constituted on 3rd October 1974 by publication in the Sarawak Government Gazette and opened to the public in 1985. (Refer to Appendix 2).

8.2. Forest Department Administration.

The Sarawak Director of Forests is responsible to.the Ministry for the management of the park, according to the rules and regulations contained in the National Parks and Nature Reserve Ordinance and the Wildlife Protection Ordinance, amended 1998. (Refer to Appendix 12 and 13).

8.3. National Parks Division Administration.

Administration of National Parks is undertaken by the National Parks and Wildlife Division within the Forest Department, from the head office in Kuching. The senior officer in charge (Senior Assistant Director) is directly responsible to the Director of Forests, as the Chief Park Warden.

A sub office in Miri with a senior officer in charge of the northern division parks is designated as the Assistant Chief Park Warden of the parks in his division.

8.4. Gunung Mulu National Park Administration.

At the Park Head Quarters an executive forest officer is designated as the Park Warden, (Officer in Charge), with one assistant and three Park Rangers. Two other permanent staff include a boatman and foreman. Park guides; office clerk; receptionist; house keepers; plant operators and labourers are employed on a yearly contract basis. All visitors are required to be guided by a National Park Guide or a Licensed Tour Guide and a guide fee is levied. The maximum group size for the show caves (caves with paths and lighting open to tourists), is ten persons. For the nature trails; pinnacles; head hunters; summit trails and adventure caving activities, the maximum group size is six persons. (Refer to Figures 8 and 9).

8.5. Park Guide Training.

Training is conducted on a regular basis and assessments made for professional certification. (Gill, 1995a, 1996a, 1997a, 1997b, 1998a, 1999).

These training courses are run by the National Parks Division and the Ministry of Tourism and a professional Tour Guides License issued to independent Freelance guides and guides employed directly by a tour company. These guides are then allowed to guide in the show caves only, without an official Park Guide and without payment of the guide fee. Reassessment of guides is carried out on a year to year basis.

The training courses cover cave and cave rescue techniques and equipment; the Ordinance; protection of wildlife; forest ecology; geology; speleology and general guiding skills. Interpretation and English language courses are conducted by the Ministry of Tourism.

8.6. Zoning. (Refer to figure 10)

This consists of small areas of high density use zones around the Park Head Quarters and the trails to the four show caves and the four caves. Low density use zones which include the trails to the Melinau Gorge Camp, (Camp 5), the Pinnacles, the Summit and Head Hunters Trail. (Refer to figures 8 and 9). Traditional use zones for subsistence hunting and gathering of forest produce and large areas of wilderness zones. The wilderness zones including 95% of the caves are strictly protected. No access is allowed to the general public. Research is allowed but only with permission from the Director of Forest. (Gill, 1993).

8.7. Carrying Capacities.

The criteria used for the carrying capacities in high density use zones and low density use zones has been calculated using the formula of environmental impact, physical factors and visitor management.

8.7.1. High density use zones.

All the caves in Gunung Mulu can be classified as high energy caves, as all have adequate air circulation. High carbon dioxide levels from visitors does not pose a problem, therefore cave formation growth is not effected by high visitor numbers. The visitors are restricted to paths, ensuring that the cave fauna and floor deposits are not disturbed. Strict rules for entry to the caves are imposed. Smoking, eating, littering, bright lights, and loud noise are not permitted.

Maximum group size per cave guide is limited to ten persons for the four show caves, at 20 minute intervals; equating to 240 persons calculated over a period of 8 hours. This figure could be increased to 480 persons per day with the construction of circular routes. Circular walkways could be constructed in three of the four show caves but not in Lang's Cave which is physically too small. At the present time (1999) visitor numbers does not warrant one way traffic, but this will be reviewed at a later date. Two more caves are under consideration for future development if the need arises. (Gill, 1997c).

8.7.2. Low density use zones.

The low density use zones include the trails and the caves open for adventure caving activities. Group size in all cases is limited to six persons plus one guide. The carrying capacities for the low density use zones has been restricted to 60 persons per day. (Sarawak Forest Department, 1993)

8.8. Management Plans.

The first Management and Development Plan was prepared by J. A. R. Anderson, A.C. Jermy and The Earl of Cranbrook in 1982 and published by the Royal Geographical Society, London. (Anderson et al, 1982).

The second Management Plan covering the years 1993 to 1995 was compiled and published by the Sarawak Forest Department in 1992. (Sarawak Forest Department, 1992). The third Management Plan is in preparation at the present time, (1999).

8.9. Development and Management.

Visitor statistics show over 15,000 visitors per year, 50 percent being from foreign destinations. A park permit is necessary for entry to the park, obtainable from the Park Head Quarters and it is stipulated in the regulations that all visitors must be accompanied by a Park Guide.

RM. 1.5 million was spent in 1998 on redevelopment and maintenance projects.
The proposed road through the park linking to the town of Limbang was dropped by the state government in favour of an alternative route, skirting the park boundary.

8.9.1. The Park Head Quarters.

The Head Quarters situated on the true left bank of the Melinau River, within the park boundary, has been developed from 1985 onwards and includes an administrative office; interpretation centre; audio visual room; toilet block and a visitor registration building. Stores; boat sheds; fuel store; generator building and 4 - units of officers quarters, plus 5 - barrack blocks for the staff complete the Park Head Quarters. Electricity is generated on site.

8.9.2. Visitor facilities.

Visitor facilities include 4 units of air condition chalets; a guest house with 8 - bedrooms and 3 VIP rooms; hostel accommodation; 2 units of 4- room chalets and a canteen. The trail to the summit of Gunung Mulu, is a 24 kilometre trek, with 3 small timber buildings; Camps 1; 3 and 4 with sleeping accommodation for 20 persons. Camp 1 is presently (1999) being reconstructed. The trek to the summit normally takes 4 days and 3 nights. Fixed ropes are in place on a number of steep climbs.

The trail to the limestone pinnacles of Gunung Api, a 2.4 kilometre long, 1100 metre climb has also been established. Ladders and ropes have been installed on steep sections. A timber building in the Melinau Gorge, (Camp 5), with sleeping accommodation for 60 persons has been constructed with solar panel lighting; showers; toilets; dinning and kitchen areas. To reach Camp 5 involves a one hour boat ride to Kuala Barer and a 7.8 kilometre trek to the camp.

A Ranger Post at Mentawai has also been constructed with 2 – units of staff barracks and office, 1 unit of Hostel accommodation and 2 - units of Chalets.

The Head Hunters Trail is a 11.3 kilometre trek through primary peat swamp and alluvial forest. The trek starts from the Mentawai Ranger Post to Camp 5.
(Refer to figures 8 and 9).

8.9.3. Cave and trail development.

Four caves have been developed for visitors with cement and timber walkways and electric lighting.

These are Deer Cave; Lang's Cave; Wind Cave and Clearwater Cave. Also cement and timber walkways have been constructed to the caves to prevent severe erosion. High density use tracks are hardened using local timber walkways and concrete in wet places, the timber being Belian Batu (Iron Wood).

Low density use forest trails are demarcated with coloured paint on the trees, left in their natural state and are cleared annually.

Realignment is occasionally carried out if erosion becomes too severe, the old trail is then left to regenerate.

8.9.4. Redevelopment of the show caves.

The walkways and lighting in the caves have now reached the end of their life span and redevelopment is in progress based on sound environmental principles.

Both Wind Cave and Clearwater Caves are presently (1999) under redevelopment. (Gill, 1995b). Galvanised steel is being used for the main walkway structure with Belian Batu (IronWood) timber decking, and where possible cement paths. The old lighting installation is being replaced with a system of electrical lighting utilising timer circuits. This is in order to reduce the effects of lampa flora, green algae growth on cave formations due to ultra violate radiation.

New Belian Batu (IronWood) timber walkways were constructed in Lang's Cave in 1998 and the electrical lighting installation replaced.

The old timber walkway to Deer Cave is presently (1999) being replaced with Belian Batu.

The Deer Cave walkway constructed of raised Belian Batu and cement paths is still in good condition but the electrical lighting will be improved in a future phase of development. The lighting in Deer Cave is kept to an absolute minimum in order to prevent disturbance to the bat roosting areas. No bright lights are permitted and electrical lighting is restricted to low wattage path lights and shaded spotlights pointing in a downward direction.

Malaysian Airline flights from the Mulu airport were banned after 1630 hours as the bats fly across the flight path. As far as is known Sarawak is the only country in the world to halt scheduled flights in order to protect its bat populations.

8.9.5. Electrical generation.

Electrical generators powered by diesel engines are situated at both Deer Cave and Clearwater Caves. These are presently (1999) being removed and mains cables installed from the Park Head Quarters electrical generators to the caves. (Gill, 1996b). This will reduce the possibilities of air, noise and water pollution.

8.9.6. Future development.

Future development is planed for circular round tours in Wind Cave, Clearwater Cave and Deer Cave in order to cater for any increase in visitor numbers without exceeding carrying capacities. Two further caves have been studied for development at a future date as show caves. (Gill, 1997c)

Water purification and waste disposal development proposals are presently under consideration and planning.

8.9.7. Adventure caving trails.

Seven wild cave trails are open for visitors designated as adventure caving activities. The visitors are guided by professional trained guides, fixed aids (safety ropes) are inspected on a regular basis. Also visitors are restricted to trails known by the guide and are not permitted to wander over delicate floor formations or disturb cave fauna. Littering is not allowed and all spent calcium carbide used for lighting is removed.

8.9.8. Development guide lines.

The IUCN Guide Lines for Cave and Karst Protection (Watson et al. 1997) are taken into account for all karst and cave development and management strategies for the Gunung Mulu National Park.

Over 90 percent of the park area and 95 percent of the caves are closed to visitors except for research purposes. (Gill, 1993).

8.10. Community Participation.

8.10.1. Park objectives.

One of the main objectives of the park is the well being of the local community. Wherever possible labour is recruited from the local community, which includes Penan and Berawan. (Liam and Gill, 1999).

The park directly employs 47 individuals of which 40 are from the local community groups. Many of the Tour Operators staff including the staff of the nearby Royal Mulu Resort are also recruited from the local groups.

8.10.2. Community benefits.

Over RM 600,000 per year is spent directly by the government on salaries and local contracts. Coupled with the yearly payroll of RM 1.1 million from the Royal Mulu Resort, the park has brought considerable employment and financial benefits to the local communities.

A number of the Tour Agency Companies are directly or partly owned by the Berawans. The airport also employs locally recruited staff. Canteens, bars and a few shops have been constructed outside the park boundary and opened by local entrepreneurs.

Local farmers sell fruit, vegetables, fish, eggs and chicken to the restaurants and canteens but at present this is by no means self sufficient. The majority of the food supplies are transported to Gunung Mulu via river or air transport.

The freelance guides and freelance boat operators are recruited from the local Berawan and Penan communities, but there is still much more to be done in order to integrate the local communities into the park infrastructure and tourism in general. The process is ongoing.

Freelance Guides and Boat Operators Associations have been proposed by the park management.

8.10.3. Special Park Committees.

The 1998 National Parks and Nature Reserve Ordinance contains provisions for Special Park Committees. These committees will consist of representatives from the local communities and the park management, with the objective of assisting the park management. Provision is also made for certain revenues generated from the park to be assigned for community development programmes, bringing further benefits to the local native groups. (Refer to Appendix 12).

8.11. Concession Management.

Provision is made in the 1998 National Parks and Nature Reserve Ordinance for Concession Management of National Parks and Nature Reserves.

Any concessions awarded will be strictly controlled under the above Ordinance and the Wildlife Protection Ordinance 1998. Besides conservation and visitor enjoyment, community benefits and participation by the local communities in the Concession Company will be stipulated in any concession agreement. This will include a share of the revenue created for community development programmes. Besides the government the two communities of Penan and Berawan will be stakeholders in any Concession Company. (Refer to Appendix 12).

8.12. Threats.

8.12.1. Natural threats.

The region is tectonically stable but normal landslides do occur on steep sided slopes. (Day, 1980).

A severe tropical storm in 1994 destroyed a considerable portion of karangas forest, which is now in the process of natural regeneration.

Annual flooding and backing up of the Melinau River is a regular occurrence during the rainy season but increased in regularity during the La Nina phenomena in 1998-99. Annual flooding is a normal and natural process being an integral part of the general biological processes of reparian and peat swamp forest dynamics.

The catastrophic El Nino effect in 1997 and 1998 brought long periods of dry weather. Man made forest fires were common throughout Sarawak during this period but the Gunung Mulu National Park was not effected. Occasional natural forest fires on the dry karst mountains have been known to occur during the dry season, the last one in 1997 destroyed a considerable area on Gunung Api, Gunung Benarat and Gunung Buda. The natural regeneration of the vegetation on the karst mountains takes a considerable period. One such area of naturally occurring forest fire was identified on Gunung Api. This was calculated as dating back a few hundred years. As the word api means fire in Bahasa Malaysia, it is presumed to be a common occurrence.

8.12.2. Human disturbance. (Refer to Figure 11)

The environmental damage from tourism is negligible and controllable but the local indigenous groups have gazetted privileges. (Refer to Appendix 11). Both Berawan and Penan have hunting and collecting privileges in subsistence hunting zones within the park.

8.12.2.1. Gazetted privileges. (Refer to Appendix 11).

The Penan were awarded privileges to hunt and collect within the entire park providing they remained nomadic. Now they are settled at the two long houses bordering the park, Batu Bungan and Long Iman, their privileges revert to that of the Berawans.

The Berawan privileges cover the subsistence zones of the catchment areas of the Lansat, Tapin and Melinau Paku Rivers. The Penan do not at present recognise these reverted privileges and still hunt within all the park area.

Collecting of forest produce and hunting of animals is restricted to certain species. This is often abused and the increasing population has brought severe pressure on the wildlife.

8.12.2.2. Social development.

A stricter regime of enforcement is required, coupled with further community involvement in the management and the benefits created. Community social development programmes are planned for the future coupled with participation of the indigenous groups in the general management of the park. (Liam and Gill, 1999). The park cannot support the present level of hunting.

8.12.2.3. Nomadic Penan's. (Refer to Figure 11).

Small groups of Penan's by choice are still nomadic and reside within the park boundary on the east side. The exact number is not known at present but is suspected as being less than 10 persons. Many of the Penan although settled still practice a semi-nomadic existence and spend considerable periods of time living in temporary shelters and hunting within the Gunung Mulu National Park.

8.12.2.4. Outside development.

Development outside the park boundary has resulted in pollution to the Melinau River, and severe erosion of the riverbanks due to tree clearing for rice cultivation and housing. Replanting of trees along the riverbanks, control of further development and waste disposal management is planned for the future.

8.12.2.5. Logging encroachment.

Logging encroachments across the boundary are hard to detect and have occurred, there is a need to increase boundary patrols on foot and by helicopter to at least four times per year.

9. COMPARISON WITH OTHER SIMILAR PROPERTIES.

Currently caves and karst are underrepresented in the World Heritage List.

World Heritage declared sites include the Mammoth/Flint Ridge cave system, Kentucky; Skojankse Jama, Slovenia; Castleguard Cave, Canada; Aggtelek-Domica karst, Hungary/Slovakia; Carlsbad Caverns, USA; Plitvice Lakes, Croatia; East Rennel, Soloman Islands; Nahanni Grand Canyon, South-west Tasmania; Te Wahipounamu, South-west New Zealand and the Naracoorte Caves and Riversleigh Fossil sites, Australia.

Nominations are under evaluation for St Pauls Cave, Palawan, Philippines; Baliem River karst, Lorents National Park, Irian Jaya and Phong Nha in Vietnam.

The vast majority of existing World Heritage sites in karst areas are in temperate regions, and the tropical karst and caves of the Mulu National Park would therefore complement and extend the other examples of World Heritage karst. The nomination would also complement the Niah and Kinabalu nominations and Taman Negara National Park.

10. CONCLUSION.

The Gunung Mulu National Park provides very significant and unique tropical cave and karst features and ecosystems in a relatively undisturbed state, with effective management and training programmes already in place. It has universal significance in terms of its geology, geomorphology and biology. Its educational and recreational values in the region are undisputed.

World Heritage status will provide due recognition of, and invaluable support to, the efforts of the Sarawak State Government and the Government of Malaysia to ensure the continuing management and protection of the great natural resource of the Gunung Mulu National Park together with the development of outstanding research, interpretation and community development programmes.

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APPENDIX 1: THE GUNUNG BUDA NATIONAL PARK NOTIFICATION.

SARAWAK GOVERNMENT GAZETTE

20th August, 1998 2233

No. 2178

THE NATIONAL PARKS AND NATURE RESERVES ORDINANCE

THE GUNUNG BUDA NATIONAL PARK NOTIFICATION, 1998

(Made under section 3(1))

Pursuant to section 3(1) of the National Parks and Nature Reserves Ordinance (Cap. 127 (1958 Ed.)), the Majlis Mesyuarat Kerajaan Negeri has made the following Notification:

1. This Notification may be cited as the Gunung Buda National Park Notification, 1998.

2. It is the intention of the Majlis Mesyuarat Kerajaan Negeri to constitute the are described in the Schedule as a National Park, and to be known as the Gunung Buda National Park.

SCHEDULE

Name : Gunung Buda National Park.
Division : Limbang.
District : Limbang.
Area : 6235 hectares approximately.
Boundaries : Commencing from the river confluence of Sungai Medalam and Sungai Mentawai, the boundary follows the true left bank of Sungai Medalam downsteam for 1318 metres to meet a bridge; thence follows the logging road towards generally easterly direction 5809 metres, thence follows a cut line of bearing 139 00' for 467 metres until it meets Sungai Assam, thence follow Sungai Assam upstream for 2840 metres to its confluence with a unnamed tributary, thence follows the tributary upstream for 1905 metres to meet a logging road; thence follows this logging road towards generally north-east-northern direction for 3303 maetres to a road junction, thence follws another logging road to follow north-eastern direction for 3675 metres to meet a stream; thence follows this stream going downstream for 1314 metres to its confluence with Sungai Senap; thence follows Sungai Senap going upstream for 6807 metres; thence turns to follow a logging road generaly towards south-western direction for 7876 metres; thence follows a cut line of bearing 225 00' for 600 metres to cross a watershed; thence follows another logging road going generally towards south-western direction for 3883 metres to meet Sungai Medalam; thence it follows the true left bank of Sungai Medalam downstream for 16010 metres metres to come back to the point of commencement.

Note : The bearing and distance are approximate, demarcation on the ground is considered correct.

Date this 25th day of June, 1998.

KIT SU LEN,
Clerk to Majlis Mesyuarat Kerajaan Negeri

APPENDIX 2: THE HISTORY.

EXPLORATION, RESEARCH AND CONSTITUTION HISTORY OF THE GUNUNG MULU NATIONAL PARK.

1. 1858. Spencer St. John, "Consul General to Borneo", visited the region and attempted to climb to the Summit of Gunung Mulu, but was, "thwarted by limestone cliffs, dense jungle and sharp pinnacles of rocks".

2 1932. Edwards Shackleton with the Oxford University Expedition, lead by a Berawan Tama Nilong and a group of Berawan porters reached the Summit of Gunung Mulu.

3 1961. Dr G. E. Wilford of the Borneo Geological Survey, mapped and explored, Deer Cave, parts of Wind Cave and a few other caves of Gunung Api and Benarat.

4 1960 - 1973. Dr J. A. R. Anderson and Dr Paul Chai of the Sarawak Forest Department carried out a series of expeditions, which revealed the areas remarkable bio-diversity, with over 100 new botanical species. Their findings resulted in the recommendations for the Mulu National Park to be constituted.

5. 1974. The park was formally constituted.

6 1977 - 1978. The first major expedition organized by the Royal Geographical Society and the Sarawak Forest Department spent over 15 months in the field. Over 100 scientists took part and all the inventories of species and the Management Plan was compiled. Over 45 kms of caves explored and mapped during this expedition revealing Deer Cave as the largest cave passage in the world.

7 1980. The exploration of the caves continued with a further 50 kms explored and mapped by cave explorers from the UK, helped by local Berawan guides. The worlds largest underground chamber was discovered Sarawak Chamber in a cave called Nasib Bagus, and geomorphological and cave biological studies undertaken.

8 1984. A further UK cave exploration expedition continued the work, bringing the total of cave passage explored to 160 kms.

The Clearwater Cave System reached a total length of 48 kms.

9. 1988. Another UK cave exploration expedition discovered a connection between Wind Cave and Clearwater Cave, bringing the total length of the Clearwater Cave System to 56 kms, the longest cave in South East Asia.

A major cave called Black Rock Cave was discovered and mapped for 12 kms, which was thought to be a part of the upper Clearwater Cave System.

10. 1989. The next UK based cave exploration expedition increased the length of Clearwater to 74 kms and Black Rock Cave to 25 kms in length, bringing the two caves closer together.

11 1991. The work of 1989 was continued, with the same UK based explorers and the connection between Clearwater and Black Rock Caves was finally established. This connection brought the total length of the Clearwater system to just over 100 kms, making it the 7th longest cave in the world and the longest cave in the whole of Asia. Cave geomorphological investigations revealed the age of the caves to be 2 million years old, possibly as old as 3 million. Uplift rates of the limestone mountains were finally es tablished at 19 cm per 1000 years.

12 1990,1994,1995 and 1997, a small separate group of British cave explorers made significant discoveries in the Southern Hills, and in the Clearwater Cave System. In 1995 Leopard Cave was also extended and connected to the Clearwater Cave System increasing its length to over 107 kms.

13. 1993. A Sarawak Forest Department and British expedition carried out an investigation of Hidden Valley situated on the east side of Gunung Api, revealing the cave potential of the area.

14. 1995. The first USA expedition with the Sarawak Forest Department to Gunung Buda took place over a 2 month period. The Gunung Buda Caves Project found 25 kms of internationally important caves which were mapped and explored. Snail Shell Cave became the deepest cave in Borneo at 468 m and 5.8 kms in length.

15. 1996. A further USA based expedition to Gunung Buda was organized and a further 5 kms of caves explored and mapped.

16. 1996. A British and Sarawak Forest Department Expedition to Hidden Valley discovered 10 kms of major caves in this remote region of Gunung Api and geomorphological scientific investigations carried out.

17. 1997. The first Japanese and Sarawak Forest Department expedition took place at Gunung Benarat. 7 kms of caves were explored in a small limestone blocked named Bukit Terikan near Gunung Benarat.

18 1997. The second USA/Sarawak Forest Department, Gunung Buda Caves Project was jointly organized and a further 21 kms of caves explored in this mountain. Green Cathedral Cave was finally connected to Turtle Cave bringing the total length to 24.6 kms, the second longest cave in Borneo and 5th longest cave in Asia. The total length of caves explored at Gunung Buda came to 60.6 kms. Deliverance Cave was also discovered in Gunung Benarat and mapped for 3.5 kms. The constitution document was compiled by the Sarawak Forest Department based on the work of the Buda Caves Project.

19 1997. A small UK based expedition explored and mapped a cave in Batu Agong for 1.2 kms, situated outside the park boundary and made a short extension to the Clearwater System. A scientific project on soil biology was carried out in Stone Horse Cave.

20. 1998. The third UK/Sarawak Forest Department Expedition took place to Hidden Valley and a further 8 kms of caves explored. The Cobra Cave was connected through the mountain to Cloud Cave and Bridge Cave, bringing the

total length of the Cobra Cave System to over 15 kms.A further 1 Km of cave passage was explored and mapped in the Clearwater System, bringing the total length to 108 kms.

21. Clearwater still holds the record for the longest cave in Asia but due to further exploration of long caves in other parts of the world, has now dropped to 11th longest in the worlds. The total length of cave passage explored and mapped in the Mulu National Park and the Gunung Buda region comes to 295 kms.

22. History of establishment and legal status.
The following are the main details of the history of the establishment of the Park.

July, 1961	A botanical expedition was mounted by the Forest Department, Sarawak, to Gunung Mulu and the Melinau limestone massif. The results of this expedition indicated the potential of the area as a National Park and recommendations for its constitution as such were submitted to the Conservator of Forests.
July, 1962	The Board of Trustees, National Parks, approved the proposals, submitted by the Conservator of Forests, to proceed with the constitution of the Park. Draft proposals were submitted to the Chief Secretary, who agreed with the proposals and indicated that the portion of the proposed Park falling within the Medalam Protected Forest should be excised from that Protected Forest when the Park was constituted.
Sept., 1962	Draft Gazette notification submitted to Chief Secretary.
August,1963	Establishment of Malaysia, in which Sarawak became a federated State.
March, 1965	Governor in Council approved the publication of the Notice of Intention to create the Park, which was subsequently published in the Sarawak Government Gazette (Gaz. notification No. 867 of 1965).
May, 1965	Copies of draft proclamations indicating the Government's intention to constitute the Park forwarded to Residents, Fourth and Fifth Division, for posting.
Oct. 1965 to Dec. 1970	Investigation of claims against the National Park by the Residents, District Officers and Board of Trustees, National Parks.
Dec., 1970	Settlement of claims by Residents, Fourth and Fifth Divisions. Revised boundary description prepared. Note that as a result of submissions by Penghulu Baya Malang, representing the people living in the lower reaches of the Tutuh river, a substantial portion of the proposed Park, lying between the Lutut river and a line drawn from Long Melinau directly to the Brunei border, was excised from the proposed Park.

	Subsequently the Penghulu raised further objections to the constitution of the proposed Park.
Jan., 1971	Resident, Fourth Division, indicated that the interests of the Tutuh peoples had been adequately safeguarded.
Dec., 1971	Revised boundary description checked by Director of Lands and Surveys, and the location of the Berar river found to be misplaced. New revised boundary description prepared and approved by Director of Lands and Surveys.
June, 1972	Governor in Council approved the final constitution of the Park. Concurrence of Federal Government sought.
Sept., 1973	Chief Minister, Sarawak, ruled that the concurrence of the Malaysian Government to the constitution of the Park was not required.
27 Sept 1974	By Sarawak Government Gazette Notification No. 2661, that part of the proposed Park falling within the Medalam Protected Forest was excised from that protected forest.
3 Oct. 1974	The Gunung Mulu National Park was finally constituted by the publication in the Sarawak Government Gazette of Notification No. 2852 (see Appendix II). Final proclamations indicating the constitution of the Park were forwarded to the Residents, Fourth and Fifth Divisions for posting in their respective divisions.
1985	Open to public.

APPENDIX 3. THE FLORA.

Number of genera and species of flowering plants identified in the Gunung Mulu National Park.

Arranged in alphabetical order of family

Family	Number Gen.	Spp.	Family	Number Gen.	Spp.
Gymnosperms			Total	5	12
Araucariaceae	1	1			
Podocarpaceae	3	4			
Gnetaceae	1	7			
Angiosperms			Total	496	1518
Monocotyledons			Total	74	192
Apostaceacea	1	1	Maranthaceae	3	3
Araceae	9	12	Musaceae	1	1
Burmanniaceae	1	1	Palmae	9	10
Commelinaceae	7	11	Pandanaceae	20	109
Cyperaceae	2	2	Taccaceae	2	19
Flagellareaceae	4	5	Triuridaceae	1	1
Gramineae	3	5	Zingiberaceae	1	1
Liliaceae	1	3		7	9
Dicotyledons			Total	422	1326
Acanthaceae	5	8	Chloranthaceae	1	1
Alangiaceae	1	4	Clethraceae	1	1
Amaranthaceae	1	1	Combretaceae	1	2
Anacardiaceae	13	20	Compositae	2	2
Annonaceae	14	33	Connaraceae	3	4
Apoynaceae	7	8	Convolvulaceae	2	3
Aquifoliaceae	1	7	Cornaceae	1	3
Araliaceae	4	12	Crypteroniaceae	1	1
Aristolochiacea	1	1	Cucurbitaceae	1	1
Asclepiadaceae	1	1	Cunoniaceae	1	1
Balanophoraceae	1	2	Daphniphyllaceae	1	1
Balsaminaceae	1	1	Datiscaceae	1	1
Begoniaceae	1	4	Dilleniaceae	1	3
Bigoniaceae	2	4	Dipterocarpaceae	8	115

Bombacaceae	3	9	Ebenaceae	1	17
Burseraceae	3	17	Elaeocarpaceae	1	23
Campanulaceae	2	5	Ericaceae	5	39
Capparidaceae	1	1	Erythroxyllaceae	1	1
Casuarinaceae	1	1	Escalloniacea	1	5
Celastraceae	8	11	Euphorbiaceae	30	87
Fagaceae	3	29	Polygalaceae	3	14
Flacourtiaceae	7	8	Proteaceae	1	3
Gentianaceae	1	1	Rafflesiaceae	1	1
Gesneriaceae	10	41	Ranunculaceae	1	1
Gonystylaceae	1	8	Rhamnaceae	3	5
Goodeniaceae	1	1	Rhizophoraceae	3	7
Guttiferae	5	48	Rosaceae	6	12
Icacianaceae	4	6	Rubiaceae	43	116
Juglandaceae	1	1	Rutaceae	8	9
Labiatae	1	2	Sabiaceae	1	2
Lauraceae	12	63	Satalaceae	2	3
Lecythidaceae	1	2	Sapindaceae	13	21
Leeaceae	1	1	Sapotaceae	8	25
Leguminosae	16	29	Saurauiaceae	1	5
Lentibulariaceae	1	1	Simaroubaceae	3	3
Linaceae	2	2	Solanaceae	1	1
Loganiaceae	2	7	Sonneratiaceae	1	1
Loranthaceae	10	15	Staphyleaceae	2	3
Magnoliaceae	4	6	Sterculiaceae	6	9
Melastomataceae	20	54	Symplocaceae	1	4
Meliaceae	7	35	Tetrameristaceae	1	1
Monimiaceae	1	1	Thrsvrsr	6	17
Moraceae	2	42	Thymelaeaceae	3	6
Myricaceae	1	2	Tiliaceae	3	10
Myristicaceae	4	27	Trigoniaceae	1	1
Myrsinaceae	3	17	Ulmaceae	1	2
Myrtaceae	7	67	Urticaceae	7	15
Nepenthaceae	1	10	Verbenaceae	8	14
Nymphceae	1	1	Violaceae	1	2
Ochaceae	3	4	Vitidaceae	4	4
Olacaceae	4	6	Winteraceae	2	3
Oleaceae	4	11			
Piperaceae	2	9			

A preliminary list of Angiosperms and Gymnosperms recorded within Gunung Mulu National Park, compiled by J.A.R. Anderson and P. Chai, January 1978.

Gymnosperms

ARAUCARIACEAE

Agathis borneensis Warburg

PODOCARPACEAE

Dacrydium beccarii Parl. Var. beccarii
D xanthandrum Pilger

Phyllocladus hypophyllus Hook.f.

GNETACEAE

Gnetum diminutum Mgf.
G. gnemon L. var. tenerum Mgf.
G. gnemonoides Brongn.
G. leptostachyum Bl. Var. leptostachyum
G. macrostachyum Hook.f.
G. neglectum Bl.
G. cospidatom B1.

Angiosperms

Monocotyledons

ARACEAE

Agalonema simplex Bl.

Alocasia denudata Engl.

A. porphyroneura Hallier ex. Engl.
A. macrorrhiza (L.) Schott.

Amorphophallus sp.

Homalomena humilis (Jack) Hook.f.
H. humilis (Jack) Hook.f. var. ovatifolia M. Hotta
H. insignis N.E. Br.
H. sagittifolia Jungh. ex. Schoot.

Piptospatha elongata N.E. Brown

Pothos borneensis Furtado
P. insignis Engl.

Schismatoglottis mutinervia M. Hotta

Scindapsus latifolius M. Hotta

BURMANNIACEAE

Burmannia championii Thw.
B. longifolia Becc.
B. lutescens Becc.

COMMELINACEAE

Forrestia marginata Hassk.

CYPECACEAE

Cyperus kyllingia Endl.

Gahnia borniensis Benl.

Mapania cuspidata (Miq.) Uuttien

Scleria lithosperma (L.) Sw.

Thorachostachyum bancanum (Miq.) Kurz

FLAGELLARIACEAE

Hanguana malayana Merr.

Joinvillea borneensis Becc.

GRAMINEAE

Centotheca latifolia (Osb.) Trin.
C. lappacea (L.) Desv.

Racemobambos glabra Holttum

HYPOXIDACEAE

Curculigo latifolia Dryand

LILIACEAE

Dianella janica Bl.

Smilax leucophylla Bl.
S. megacarpa A.DC.
S. odoratissima Bl.

MARANTHACEAE

Donax canniformis (Forst.) K. Schum.

Phrynium capitatum Willd.

Stachyphrymium sp.

MUSACEAE

Musa campestris Becc.

ORCHIDACEAE

Anaechtochilus setaceus Bl.

Bulbophyllum memvranifolium Hk.f.

Calanthe veratrifolia R. Br.
C. triplicata (Willem.) Ames

Coelogyne moultonii J.J. Sm.

Eria longifolia Hk.f.

Malaxis aff. Nemoralis (Ridl.) Holttum

Plocoglottis aff. Javanica Bl.

Podochilus rupicola Ridl.

Zeuxine violascens (Bl.) Ridl.

PALMAE

Areca minuta Scheff.

Arenga borneensis (Becc.) Drans.
A brevipes Becc.
A undulifolia Becc.

Calamus ashtonii Drans. (ined.)
C. blumei Becc.
C. aff. Ciliaris Becc.
C. conirostris Becca.
C. divaricatus Becc.
C. divaricatus Becc. (accaulescent form)
C. equisitus Drans.
C. flabelloides Furtado
C. genospermus Becc.
C. Hewittianus Becc.
C. hispidulus Becc.

Arenga borneensis (Becc.) Drans.
A. brevipes Becc.
A. undulifolia Becc.

Calamus ashtonii Drans. (ined.)
C. blumei Becc.
C. aff. Ciliaris Becc.
C. conirostris Becca.
C. divaricatus Becc.
C. divaricatus Becc.
(accaulescent form)
C. equisitus Drans.
C. flabelloides Furtado
C. genospermus Becc.
C. Hewittianus Becc.
C. hispidulus Becc.
C. javensis Bl. Var.
C. javensis Bl. (montane taxon)
C. aff. javensis Bl.
C. kiahii Furtado
C. laevigatus Mart. Var. laevigatus
C. laevigatus Mart. Var. mucronatus (Becc.) Drans. (ined.)
C. marginatus (Bl.) Mart.
C. muricatus Becca.
C. nematospadix Becc.
C. sarawakensis Becc.
C. aff. Semoi Bec. (Taxon 1)
C. aff. Semoi Becc. (Taxon 2)
C. tenopokensis Furtado
C.. zonatus Becc.

Caryota mitis Lour.
C. no Becc.

Ceratolobus concolor Bl.
C. discolor Becc.
C. subangulatus (Miq) Becc.

Daemonorops asteracantha Becc.
D. atra Drans. (ined.)
D. didymophylla Becc.
D. formicaria Becc.
D. aff. Hystrix (Griff.) Mart. (Taxom 1)
D. aff. Hystrix (Griff.) Mart. (Taxon 2)
D. ingens Drans. (ined.)
D. korthalsii Bl.
D. longipes (Griff.) Mart.
D. macrostachys Becc.
D. oblata Drans. (ined.)
D. oxycarpa Becc.
D. pericantha Miq.
D. sparsiflora Becc.
D. spectabilies Becc.

Eugeissona utilis Becc.
E. minor Becc.

Gigliola insignis Becc.
G. subacaulis Becc.

Iguanura melinauensis Kiew

Korthalsia cheb Becc.
K. concolor Burret
K. echinametra Becc.
K. ferox Becc.
K. hispida Becc.
K. macrocarpa Becc.
K. rigida Bl.
K. aff. sca[higera Griff. Ex Mart.

Licuala borneensis Becc.
L. lanata Drans. (ined.)
L. aff. valida Becc.

Nenga pumila (Bl.) H. Wendl.

Oncosperma horridum Scheff.

Pholidocarpus maiadum Becc.

Pichisermollia insignis (Becc.) H. Monteiro Neto var. moorei Drans. (ined.)

Pinanga albescens Becc. ex H. Winkler
P. aristata (Burret) Drans. (ined.)
P. brevipes Becc.
P. capitata Becc. ex Gibbs var. capitata
P. chaiana Drans. (ined.)
P. crassipes Becc.
P. dumatosa Drans. (ined.)
P. keahii Furtado
P. lepidoda Rendle
P. malaiana (Mart.) Scheff. Var. barramensis Becc. ex. Mart.
P. minuta Furtado
P. mirabalis Becc.
P. mooreana Drans. (ined.)
P. pilosa (Burret) Drans. (ined.)
P. ridleyana Becc. ex Furtado
P. rivularis Becc.
P. salicifolia Bl.
P. tenacinervia Drans. (ined.)
P. tomentella Becc. var.

Plectocomia aff. Minor Ridl.
P. aff. muelleri Bl.

Plectocomiopsis geminiflorus (Griff.)
Becc. var. borneensis Becc.
P. triqueter (Becc.) Drans. (ined.)

Pogonotium divaricatum Drans. (ined.)

Retispatha dumatosa Drans. (ined.)

Salacca affinis Griff. Var borneensis Becc.
S. magnifica Mogea (ined.)
S. rupicola Drans. (ined.)

PANDANACEAE

Freycinetia imbricata Bl.
F. palawanensis Elm. Var. andersoniana Stone
F. sarawakensis Martelli

Pandanus anderstonii Stone
Pandanus calcinactus St. John
P. epiphyticus Martelli
P. pectinatus Martelli
P. pumilus St. John

TACCACEAE

Tacca sp.

TRIURIDACEAE
Sciaphila flexuosa Giessen

ZINGIBERACEAE
Achasma megalocheilos Griff.

Alpinia glabra Ridl.

Boesenbergia hutchinsonni Burtt and Smith
B. pulchella Ridl.

Costua of. Paradoxus K. Schum.
C. speciosus (Koenig) Smith

Geanthus fimbreobracteatus
(K. Schum.) Burtt and Smith

Geostachys sp.

Globba sanguinea Miq.

Dicotyledons

ACANTHACEAE

Borneacanthus grandifolius Brem.

Cosmianthemum magnolifolium Brem.

Hallieracantha caudata Stapf
H. salicifolia Stapf

Pseuderathemum sp.

Staurogyne of. Jaheri Brem.
S. setigera Nees

ALANGIACEAE
Alangium ebenaceum (Clarke) Harms.
A. griffithii (Clarke) Harms.
A. javanicum (K. et V.) Wang
A. ridleyi King

MARANTHACEAE
Cyathula prostrata (L.) Bl.

ANACARDIACEAE
ANDROTIUM ASTYLUM Stapf

Buchanania arborescenS (BL.) Bl.
B. aff. lucida Bl.

Campnosperma auriculatum (Bl.) Hook.f.

Dracontomelon dao (Blanco) Merr. And Rolfe

Drimycarpus racemose Hook.f.

Gluta laxiflora Ridl.

Mangifera havilanddi Ridl.

Melanochyla aff. Beccariana Olive.
M. elmeri Merr.
M. oblanceolata Merr.

Melanorrhoea beccarii Rngl.
M. macrocarpa Engl.
M. wallichii Hook.f.

Parishia maingayi Hooks.f.

Pentaspadon motleyi Hook.f.

Solenocarpus philippinensis (Elm.) Kost.

Swintonia acuta Engl.
S. schwenkii Teijsm. & Binn.

ANNONACEAE
Anaxagorea borneensis (Becc.) J. Sinclair

Cyathocalyx havilandii Boerl.
C. magnificus Boerl.

Desmos dimosa (Roxb.) Safford

Disepalum anomalum Hook.f.

Enicosanthum coriaceum (Hk.f. et Th.) Airy Shaw
E. sp.

Goniothalamus dolichocarpus Merr.
G. giganteus Hk.f. et Th.
G. malayanus Hk.f.
G. suaveolens Becc.
G. tapis Miq.
G. velutinus Airy Shaw
G. eoodii Merr.

Meiogyne virgata (Bl.) Miq.

Mezzettia leptopoda (Hk.f. et Th.) Oliv.

Neouvaria acuminatissima (Miq.) Airy Shaw

Polyalthia canagioides (Zoll.) Boerl.
P. cauliflora Hk.f. et Th. var. cauliflora
P. flagellaris (Becc.) Airy Shaw
P. hookeriana King
P. hypogea King
P. hypoleuca Hk.f. et Th.
P. jenkinsii (Hk.f. et Th.) Hk.f. et Th.
P. motleyana (Hk.f.) Airy Shaw var. motleyana
P. motleyana (Hk.f.) Airy Shaw var glabrescens
P. rumphii (Bl.) Merr.
P. sumatrana (Miq.) Kurz
P. suaveolens Becc.
P. xanthopetala Merr.

Popowia pisocarpa (Bl.) Endl.

Pseuduvaria pamateonis (Miq.) Sinclair

Sageraea lanceolata Miq.

APOCYNACEAE
Alyxia pilosa Miq.

Alstonia angustiloba Miq.

Chilacarpus denudatus Bl.

Dyera costulatus Hook.f.

Kopsia singaporensis Ridl.

Leuconotis anceps Jack

AQUIFOLIACEAE

Ilex cymosa Bl.
I. grandifolia Merr.
I. havilandii Loes.
I. laurocerasus Airy Shaw
I. sclerophylloides Loes.
I. sp. (BRUN. 1113)
I. sp. (S2,723)

ARALIACEAE
Arthrophyllum rubiginosum Ridl.

Schefflera gracilis (Miq.) Vig.
S. glaucophylla Frodin
S. lineamentorum Frodin
S. truncata Frodin
S. verticillata Frodin

ASCLEPIADACEAE

Hoya parasitica Wall.

BALANOPHORACEAE
Balanophora reflexa Becc.

BALSAMINEACEAE
Impatiens platypetala Lindl.

BEGONIACEAE
Begonia conipila Irmsch.
B. pubescens Ridley
B. baramensis Merrill

BIGNONIACEAE
Deplanche bancana (Seheff.) v. Steen.

BOMBACACEAE
Coelostegia borneensis Becc.

Durio acutifolius (Mast.) Kosterm.
D. affinis Becc.
D. dulcis Becc.
D. graveolens Becc.
D. lamceolatus Mast.
D. oblongus Mast.

Neesia glabra Becc.

BURSERACEAE
Cnarium denticulatum Bl.
C. littorale Bl. Forma rufum
C. odontophyllum Miq.

Dacypdes costata (Benn.) H.J. Lam
D. incurvata (Engl.) H.J. Lam
D. macrocarpa H.J. Lam var. macrocarpa
D. nervosa Bl.
D. rugosa (Bl.) H.J. Lam var. virgata

Santiria apiculata Benn. var. apiculata
S. apicula Benn. var. pilosa (Engl.) Kalkm.
S. grandiflora Kalkm.
S. laevigata Bl. Forma laevigata
S. megaphylla Kalkm.
S. oblongifolia Bl.
S. rubiginosa Bl. var. pedicellata

CAMPANULACEAE
Lobelia zeylanica L.

Pentaphragma acuminatum Airy Shaw
P. albiflorum H.H. Pears.
P. cyrtandriforme Airy Shaw
P. viride Stapf and Green

CAPPARIDACEAE
Crataeva nurvala Ham. Var. nurvala

CASUARINACEAE
Casuarina nobilis Whitmore

CELASTRACEAE

Bhesa paniculata Arn.

Celastrus monospermsmoides Loes.

Eupnymus castaneifolius Ridl.

Lophopetalum beccarianum Pierre
L. rigidum Ridl.
L. sessilifolium Ridl.
L. subobovatum King

Microtropis valida Ridl.

Perrottetia alpestris (Bl.) Loes. Ssp. Philippinensis

Siphonondon celastrineus Griff.

CHLORANTHACEAE
Chloranthus officinalis Bl.

CLERTHRACEAE

Clethra clementis Merr.

COMBRETACEAE
Terminalia phellocarpa King
T. subspathulata King

COMPOSITAE
Vernonia arborea Ham.

CONNARACEAE
Agelaea borneensis (Hk.f.) Merr.
A. trinervis (Llanos) Merr.

Cnestis platantha Griff.

Rourea mimosoides (Vahl) Planch. Forma mimosoides

CONVOLVULACEAE
Erycibe crassipes Ridl. E. Hoogl.
E. glomerata Bl. ssp. angustifolia (Hall.f. Hoogl.

Merremia peltata (L.) Merr.

CORNACEAE
Mastixia eugenioides Bl.
M. philippineensis Wang
M. rostrata Bl.

CRYPTERRONIACEAE
Dactylocladus stenostachys Oliv.

CUCURBITACEAE
Trichosanthes trifoliata V. Merell

CUNONIACEAE
Weinmannia aphanoneura Airy Shaw

DAPHNIPHYLLACEAE
Daphniphyllum borneense Stapf

DATISCACEAE
Octomeles sumatrana Miq.

DILLENIACEAE
Dillenia excelsa (Jack) Gilg. Var. excelsa
D. suffruticosa (Griff.) Martelli
D. reticulata

DIPTERROCARPACEAE
Anisoptera laevis Ridl.
A. marginata Korth.
A. reticulata Ashton

Cotylelobium burckii (Heim) Heim
C. malayanum v.Sl.
C. melanoxylonv.Sl.

Dipterocarpus acutangulus Vesq.
D. applanatus v.Sl.
D. apterus Foxw
D. borneensis v.Sl.
D. caudiferus Merr.
D. crinitus Dyer
D. eurynchus Miq.
D. exalatus v.Sl.
D. humeratus v.Sl.
D. lowii Hook.f.
D. oblongifolius Bl.
D. pachyphyllus Maijer
D. palembanicus v.Sl.
D. sarawakensis v.Sl.
D. stellatus Vesq.
D. verrucosus v.Sl.

Dryobalanops aromatica Gaertn. f.
D. beccarii Dyer
D. lanceolata Burck
D. rappa Becc.

Hopea andersonii Ashton
H. argentea Meijer
H. dasyrrhachis v.Sl.
H. aff. dyeri Heim
H. fluvialis Ashton
H. mengarawan Miq.
H. mesuoides Ashton
H. nervosa King
H. nutans Ridl.
H. pachycarpa (Heim) Sym.
H. pentanervia Sym.
H. pterygota Ashton
H. sangal Korth.
H. treubii Heim

Parashorea macrophylla W.Sm. ex Ashton
P. smythiesii W. Sm. ex Ashton

Shorea acuta Ashton
S. agami Ashton
S. albida Sym.
S. almon Foxw.
S. amplexicaulis Ashton
S. andulensis Ashton
S. angustifolia Ashton
S. argentifolia Sym.
S. atrinervosa Sym.
S. beccariana Burck
S. bracteolata Dyer
S. brunnescens Ashton
S. bullata Ashton
S. coriacea Burck
S. crassa Ashton
S. cristata Brandis
S. curtisii Dyer
S. dasyphylla Foxw.
S. domatiosa Ashton
S. faguetiana Heim
S. fallax Meijer
S. ferruginea Dyer ex Brandis
S. flava Meijer
S. flaviflora Wood ex Ashton
S. gibbosa Brandis
S. glaucescens Meijer
S. iliasii Ashton
S. havilandii Brandis
S. laevis Ridl.
S. leprocladus Sym.
S. macrophylla (De Vr.) Ashton
S. macroptera Dyer
S. materialis Ridl.
S. maxwelliana King
S. monticola Ashton
S. multiflora (Burck) Sym.
S. myrionerva Wood ex Ashton
S. obscura Meijer
S. ochracea Sym.
S. ovalis (Korth.) Bl.

S. ovata Dyer ex Brandis
S. palembanica Miq.
S. parvifolia Dyer
S. parvistipulata Heim
S. patoiensis Ashton
S. pauciflora King
S. pilosa Ashton
S. pinanga Scheff.
S. platycarpa Heim
S. platyclados v.Sl.
S. quarinervis v.Sl.
S. richetia Sym.
S. rubra Ashton
S. rugosa Heim
S. scaberrima Burck
S. scabrida Sym.
S. scrobiculata Burck
S. seminis (De. Vr.) v.Sl.
S. smithiana Sym.
S. superba Sym. Ex Wood
S. teysmanniana Dyer
S. venulosa Meijer
S. (Eushorea) sp. nov.

Vatica brunigi Ashton
V. coriacea Ashton
V. dulitensis Sym.
V. granulata v.Sl.
V. mangachapoi Blanco
V. oblongifolia Hook.f.
V. odorata (Griff.) Sym.
V. sarawakensis Heim.
V. sp 'A'

EBENACEAE

Diospyros borneensis Hiern
D. cauliflora Bl.
D. diepenhorstii Miq.
D. elliptifolia Merr. Forma kinabaluense Bakh.
D. evana Bakh.
D. ferruginescens Bakh.
D. frutescens Bl.
D. hermaphroditica (Zoll.) Bakh. Ex v. Steen.
D. korthalsiana Hien
D. multiflora Blanco
D. oblonga Wall. wx. G. Don.
D. pendula Hasselt. Ex. Hassk.
D. polyalthioides Hiern
D. undula G. Don
D. wallchii King et Gamble ex King
D. sp. 1 (S34,838)
D.sp. 2 (S38,037)

ELAEOCARPACEAE

Elaeocarpus acrantherus Merr.
E. angustipes Knuth.
E. clementis Merr. Var. clementis
E. congestifolius Knuth.
E. conoideus Knuth.
E. euneurus Stapf ex Ridl.
E. ferrugineus (Jack) Steud. Var. elliptifolius (Merr.) Weibel
E. floribundus Bl.
E. glaber Bl.
E. griffithii (Wight) A. Gray
E. hochreutineri Weibel
E. marginatus Stapf

E. mastersii King
E. multinervosus Knuth.
E. muluensis Weibel
E. nitidus Jack
E. obtusus Bl.
E. pedunculatus Wall. Ex. Mast.
E. petiolatus Wall.
E. pseudopaniculatus Corner
E. sadikanensis R. Knuth.
E. stipularis Bl.

ERICACEAE

Costera tetramera Sleum.

Diplycosia acuminata Becc.
D. barbigera Sleum.
D. ciliolata Hook. f.
D. elliptica Ridl.
D. fimbriata Sleumer
D. heterophylla Bl. var. latifolia (Bl.) Sleumer
D. lavendulifolia Sleumer
D. macrobracteata Argent (ined.)
D. pittosporifolia J. J. Sm.
D. salicifolia Sleumer

Rhododendron brookeanum Lour ex. Lindl. Var. brookeanum
R. buxoides. Sleumer
R. crassifoliun Stapf
R. durionifolium Becc.
R. ericoides Low ex. Hk.f.
R. himantodes Sleumer
R. lanceolatum. Ridl.
R. longiflorum Lindl.
R. micromalayanum Sleumer

R. moultonii Ridl.
R. nervulosum Sleumer var. exuberans Sleumer
R. niewenhuisii J.J. S.
R. orbiculatum Ridl.
R. quadrasianum Vid. Var. angustissimum Sleumer
R. rugosum Low ex. Hook. F.
R. suaveolens Sleum.

Vaccinium andersonni Sleumer
V. bancanum Miq.
V. claoxylon J.J. Sm.
V. clementis Merr.
V. coriaceum Miq.
V. kemulense Sleumer
V. leptanthum Miq.
V. megaphyllum Sleumer var megaphyllum
V. monanthum Ridl.
V. pachydermum Stapf
V. tenerellum Sleumer

ESCALLONIACEAE

Polyosma bracteosum Stapf
P. hookeri Stapf
P. intefrifolia Bl.
P. latifolia Schltr.
P. mjobergii Merr.

EUPHORBIACEAE

Agrostistachy longifolia (Wight) Benth. Ex Hook.
Antidesma hosei P. et H.
A. leucopodum Miq.
A. montanum Bl.
A. neurocarpum Miq.
A. tomentosum Bl. var. tomentosum

Aporusa benthamiana Hook.f.
A. caloneura Airy Shaw
A. granularis Airy Shaw
A. lunata (Miq.) Kurz
A. subcaudata Merr.
Austrobuxus nitidus Miq.

Baccaurea angulata Merr.
B. bracteata M.A.
B. costulata M.A.
B. lanceolata (Miq.) M.A.
B. latifolia King ex Hook.f.
B. maigayi Hook.f.
B. minor Hook.f.
B. motleyana (M.A.) M.A.
B. parviflora (M.A.) M.A.
B. pyriformis Gage
B. racemosa (Reinw.) M.A.
B. sumatrana (Miq.) M.A.
B. trigonocarpa Merr.
B. trunciflora Merr.

Blumeodendron Kurzii (Hk.f.) J.J. Sm.
B. tokbrai (Bl.) Kurz

Bridelia adusta Airy Shaw
B. glauca Bl.
B. penangiana Hk.f.

Cephalomappa malbricarpa Airy Shaw
Chaetocarpus castanocarpus (Roxb.) Thw.
Claoxylon stapfianum Airy Shaw
Cleidion javanicum Bl.

Cleistanthus brideliifolius C.B. Rob
C. glaber Airy Shaw
C. myrianthus (Hassk.) Kurz
C. sumatranus (Miq.) M.A.

Croton argyratus Bl.
C. oblongus Burm.f.

Drypetes longifolia (Bl.) P. et H.
D. miccophylla (Merr.) P.et H.
D. sibuyanensis (Elm.) P. et H.

Elateriospermum tapos Bl.

Endospermum peltatum Merr.

Excoecaria borneensis P. et. H.
Glochidion Calospermum Airy Shaw
G. lutescens Bl.
G. macrostigma Hook.f.
G. obscurum (Roxb. Ex Willd.) Bl.
G. rubrum Bl.

Homalanthus popuuneus (Geisel.) Pax.

Macaranga beccariana Merr.
M. brevipetiolata Airy Shaw
M. caladiifolia Becc.
M. conifera (Zoll.) M.A.
M. hosei King ex Hook.f.

M. pruinosa (Miq.) M.A.
M. triloba (Bl.) M.A.
M. winkleriella Whitmore

Mallotus dispar (Bl.) M.A.
M. lackeyi Elmer
M. penangensis M.A.
M. wrayi King ex Hk.f.

Moultonianthus leembruggianus
(B. et K.) v. Steen.

Neoscortechinia forbesii Pax.
Ex S. Morre
N. kingii (Hook.f.) P. et H.
N. sumatrensis S. Moore var. sumatrensis

Omphalea malayana Merr.

Pimel odendron graffithianum
(M.A.) Benth.

Ptychopyxis arborea (Merr.) Airy Shaw

Trigonopleura malayana Hook.f.

Trigonostemon malaccanus M.A.

FAGACEAE

Castanopsis foxworthyi Schottky
C. motleyana King

Lithocarpus andersonii Soepadmo
L. bennettii (Miq.) Rehd.
L. cantleyanus (King ex Hk.f.) Rehd.
L. confertus Soepadmo
L. conocarpus (Oudem.) Rehd.
L. coopertus (Blanco) Rehd.
L. encleisacarpus (Korth.) A. Camus
L. gracilis (Korth.) Soepadmo
L. hatusimae Soepadmo
L. lampadarius (Gamble) A. Camus
L. leptogyne (Korth.) Soepadmo
L. luteus Soepadmo
L. nodosus Soepadmo
L. papillifer Hatus. Ex Soepadmo
L. pseudokunstleri A. Camus
L. pulcher (King) Margraf
L. pusillus Soepadmo
L. revolutus Hatus. Ex Soepadmo
L. sundaicus (Bl.) Rehd.
L. turbinatus (Stapf) Forman
L. sp. nov.
L. sp. (S34,055)

Quercus argentata Korth.
Q. lmeri Merr.
Q. subsericea A. Camus
Q. valdinervosa Soepadmo

FLACOURTIACEAE

Casearia capitellata Bl.

Flacourtia rukam Zoll. stet Mor.

Homalium foetidum (Roxb.) Benth.

Hydnocarpus woodii Mer.

Pangium edule Reinw. Ex. Bl.

Ryparosa acuminata Merr.

Scolopia spinosa (Roxb.) Warb.

GENTIANACEAE

Cotylanthera tenuis Bl.

GESNERIACEAE

Aeschyanthus parvifolius R. Br.
A. tricolor Hook.
Agalmyla borneensis (Schlech.) B.L. Burtt
A. johannis-winkleri (Kraenzl.) B.L. Burtt
A. sp. nov.

Boea treubii Forbes

Cyrtandra bracheia B.L. Burtt
C. digitaliflora B.L. Burtt
C. aff.gibbeiae S. Moors.
C. incsustata (Bl.) Burtt
C. multibracteata C.B. Cl.
C. oblongifolia (Bl.) C.B. Cl.
C. penduliflora Kraenzl.
C. radiciflora C.B. CI.
C. trisepala C.B. Cl.
C. woodsii B.L. Burtt
C. sp. 71.
C. sp. 142.

Didymocarpus simplex kraenzl.

Epithema involucratum (Roxb) B.L Burtt

Loxocarpus conicapsularis (C.B. Cl.)
B.L. Burtt
L. verbeniflos (C.B. cl.) Burtt

Monophyllaea beccarii C.B. Cl.
M. horsfieldii R. Br.
M. johannis – winkleri Kraenzl.

Paraboea clarkei B.L. Burtt

GONYSTYLACEAE

Gonystylus acuminatus Airy Shaw
G. bancanus (Miq.) Kurz
G. brunnescens Airy Shaw
G. calophylloides Airy Shaw
G. forbesii Gilf.
G. nervosus Airy Shaw
G. velutinus Airy Shaw

GOODENIACEAE
Scaevola micrantha Presl

GUTTIFERAE
Calophyllum biflorum Hend.
And W. – Sm.
C. curtisii King
C. elegans Ridl.
C. ferrugineum Ridl.
C. garcinioides P.F.Stevens (ined.)
C. hosei Ridl.
C. inophylloide King
C. pulcherrimum Wall. ex.
Planch et Trian.
C. nodosum Vesq.
C. teysmannii Miq. Var. inophylloide
Cratoxylum arborescens (Vahl.) Bl.
C. formosum Jack) Dyer ssp. formosum

Garcinia apetala Pierre
G. beccarii Pierre
G. benthamiana Pierre
G. blumei Pierre
G. borneensis Pierre
G. brevipes Pierre
G. calophyllifolia Ridl.
G. caudiculata Ridl.
G. cuneifolia Pierre
G. cuspidata King
G. divers King
G. dryobalanoides Pierre
G. dulcis Pierre
G. gaudichaudii Planch. Et. Trian.
G. hombroniana Pierre
G. maingayi Hook.f.
G. memecyloides Ridl.
G. miquelii Pierre
G. nitida Pierre
G. parvifolia (Miq.) Miq.
G. petiolaris Pierre
G. rostrata Hassk.
G. sarawakensis Pierre
G. vidua Ridl.
G. sp. 'B'
G. sp. 'D'
G. sp. 'E'
G. sp. No. 45.

Mammea anastomosans (Miq.) Kost.
M. calciphila Kost.
M. reticulata Kost.
Mesua acuminatissima (Merr.) Kost.
M. calophylloides (Ridl.) Kost.
M. elmeri (Merr.) Kost.
M. grandis (King) Kost.
M. myrtifolia (Baill.) Kost.

ICACINACEAE

Gomphandra cumingiana (Miers) F. – Vill.

Phytocrene racemosa Sleumer

Platea latifolia Bl.

Stemonurus malaccensis (Mast.) Sleumer
S. scorpioides Becc.
S. umbellatus Becc.

JUNGLANDACEAE

Engelhardtia serrata Bl.

LABIATAE

Gomphostemma javanica Benth.

LAURACEAE
Actinodaphne borneensis Meissn.
A. glomerata Nees
A. myriatha Merr.
A. pruinosa Nees

Alseodaphne bancana Miq.
A. insignis Gamble
A. rurolignea Kost.

Beischmiedia gemmiflora Kost.
B. glabra Kost.
B. glauciphyla Kost.
B. madang Bl.
B. maingayi Hook.f.
B. micrantha Merr.
B. palembanica (Miq.) Kost.
B. perakensis Gamble
B. phoebeopsis Kost.
B. pilosa Kost.
B. sp. nov
B. sp. 'A'

Cinnamomum iner Reinw. Ex Bl.
C. microcarpum Kost.
C. sp. S31,801
Cryptocarpa cageyensis Merr.
C. kurzii Hook.f.
C. laevigata Bl.
C. taeaensis Merr.

Dehaasia cuneata Bl.
D. firma Bl.
D. incrassata (Jack) Kost.
D. membranaceae Kost.

Endiandra coriaceae Merr.

Eusideroxylon melagangai Sym.
E .zwageri T. & B.

Lindera bibracteata (Bl.) Boerl.
Var rufa (Stapf) Kost.
L. caesia Reinw. Ex Villar
L. rufa Gamble
L. subumbellifera (Bl.) Kost.

Litsea accedens (Bl.) Boerl.
L. cordata (Jack) Hook.f.
L. caulocarpa Merr.
L. cylindrocarpa Gamble
L. elliptibacca Merr.
L. erectinervia Kost.

L. ficoidea Kost.
L. firma (Bl.)Hook.f.
L. fulva Vill.
L. grandis Hook.f.
L. lancifolia Vill.
L. lanceolata (Bl.) Kost.
L. machilifolia Gamble
L. nigricans (Missn.) Boerl.
L. ochracea Boerl.
L. oppositifolia (Bl.) Vill.
L. petiolata Hook.f.
L. varians (Bl.) Boerl.
L. sp. 'A'
L. sp. 30

Nothaphoebe havilandii Gamble
N. heterophylla Merr.
N. macrantha Kost.

Phoebe declinata Bl.
P. sterculioides Elm.

LECYTHIDACEAE

Barringtonia lanceolata (Ridl.) Payens
B. revoluta Merr.

LEEACEAE

Leea acculeata Bl.

LEGUMINOSAE

Copaifera palustris (Sym.) De wit

Crudia reticulata Merr. Ex De Wit

Dalbergia havilandii Prain

Derris elegans (Grah.) Benth.
D. malaccensis (Benth.) Planch.

Dialium cochinchinense Pierre
D. indum L.
D. laurinum Baker
D. sylvestre De Wit

Fordia filipes Dunn
F. johorensis Whitmore

Koompassia excelsa (Becc.) Taubert
K. malaccensis Maingay ex Benth.

Mucuna biplicata T. et B.

Parkia sumatana Miq.

Phanera argentea De Wit
P. bidentata (Jack) Benth.
P. kockiana (Korth.) Benth.

Pithecellobium borneense Benth.

P. clypearia (Jack) Benth.
P. motleyana Jack
P. oppositum Miq.

Saraca declinata (Jack) Miq.

Sindora cociacea Maingay ex Prain
S. irpicina De Wit
S. leiocarpa Backer ex. K. Heyne
Whitefordiodendron myrianthus
(Dunn) Dunn

LINACEAE

Ctenolophon parvifolius Olive.

Ixonanthes beccarii Hall.

LOGANIACEAE

Fagraea auriculata Jack ssp. borneensis
(Scheff.) Leen.
F. blumei G. Don
F. ceilanica Thunb.
F. elliptica Roxb.
F. fragrans Roxb.
F. racemosa Jack ex Wall.

Strychnos ovata Hill

LORANTHACEAE

Barathranthus axanthus (Korth.) Miq.

Elytranthe albida (Bl.) Bl.

Helixanthera xestophylla (Miq) Danser
H. maxwelliana (Gibbs) Danser

Lepeostegeres inconspicuus Danser
L. lenceifolius van Tiegh.

Laxanthera speciosa Bl.

Macrosolen beccarii Becc.
M. sp.S38,026

Scurrula ferruginea (Jack) Danser

Trithecanthera xiphostachys v. Tiegh

MAGNOLIACEAE

Aromadendron elegans Bl.
A. nutans Dandy

Magnolia maingayi King

Michelia sp. 'A'

Talauma gigantifolia Miq.

MELASTOMATACEAE

Anerincleistus beccarii Cogn.
A. glomeratus King

Astronica cumingiana Vidal

Blastus cogniauxii Stapf

Dalenia pubescens Merr.

Driessenia axanthe Korth.
Driessenia glanduligera Stapf

Kibessia azurea (Bl.) DC.
K. galeata (Bl.) Cogn.
K. gracilis Cogn.
K. verrucoasa Merr.

Medinilla caressifolia (Reinw. Ex. Bl.) Bl.
M. cuspidata Bl.
M. muricata Bl.
M. radicans (Bl.) Bl.
M. sepiosa Bl.

Melastoma beccarianum Cogn.
M. molle Korth. Var parva
M. muticum Rid.
M. saguineum Sime
M. sp.S35,892

Memecylon acuminatum Sm.
M. beccarianum Cogn.
M. borneense Merr.
M. costatum Miq.
M. crassifolia Bl.
M. edule Roxb.
M. elmeri Merr.
M. garcinioides Bl.
M. globosum Bakh.f.
M. laevigatum Bl.
M. laurinum Bl.
M. ovatum Sm.
M. scolopacinum Rid.

Neodissochaeta celebica Nayar
Phaulanthus acuminatissimus Ridl.
Phyllagathis elloptica Stapf.

Plethiandra hookerii Stapf
P. motleyi Hook.f.
Pternandra caerulescens Jack

Sonerila beccariana Cogn.
S. pulchella Stapf.
S. purpurascens Cogn.
S. tenuifolia Bl.
S. sp. B2,133

MELIACEAE
Aglaia affinis Merr.
A. bernardio Merr.
A. borneensis Merr.
A. brachybotrys Merr.
A. chaudocensis Pierre
A. cordata Hiern
A. cuspidella Ridl.
A. havilandii Ridl.
A. harmsiana Parkin.
A, odoratissima Bl.
A. palembanica Miq.
A. polyantha Ridl.
A .rufa Miq.
A .trichostemon C. DC.
A. trimera Ridl.
A. triplex Ridl.
A .unifoliata Ridl.
A. sp. 11

Amoora rubiginosa Hiern

Aphanamixis (Miq.) Harms

Azadirachta excelsa (Jack) Jacobs

Chisocheton beccarianum (Baill.) Harms
C. ceramicus (Miq.) C. DC.
C. macranthus (Merr.) Airy Shaw

Dysoxylum acutangulum Miq.
D. alliaceum Bl.
D. cauliflorum Hiern
D. macracarpum Bl.
D. rubrum Merr.
D. thyrsoideum Griff.
D. undulatum Bl.

Sandoricum koejape (Burm.f.) Merr.
S. maingayi Hiern

MONIMIACEAE
Matthaea sancta Bl.

MORACEAE
Artocarpus anisophyllus Miq.
A. dadah Miq.
A. elasticus Reinw. Ex Bl.
A. lanceifolius Roxb.
A. nitidus Tree.
A. odoratissimua Blanco
A. ovatus Blanco
A. rigidus Bl.

Ficus binnendijkii Miq.
F. callicarpus Corner
F. deltoidea Jack var. intemedia Corner
F. deltoidea Jack var. lutescens (Desf.) Corner
F. deltoidea Jack var. kinabaluense Corner
F. eumorpha Corner
F. francisci Winkler
F. geocharis Corner
F. hemsleyana King
F. lamponga Miq.
F. lepicarpa Bl. var. brevibracteata Corner
F. leptograma Corner
F. macilenta King
F. microcarpa Linn.f.
F. midotis Corner
F. oleaefolia King var. memecylifolia Corner
F. oleaefolia King var. mysinoides Corner
F. oleaefolia King var. oddonaeformis Corner
F. punctata Thunb.
F. rubrocuspidata Corner
F. rubromidotis Corner
F. schwarzii Koord
F. subulata Bl.
F. sumatrana Miq.
F. tinctoria Forst.f. spp. gibbosa (Bl.) Corner
F. uniglandulosa Wall. var. parviflora Miq.

MYRICACEAE
Myrica esculenta Buch.-Ham.
M. javanica Bl.

MYRISTICACEAE
Gymnacranthera contracta Warb.
G. eugeniifolia (A. DC.) var. griffithii (Warb.) J. Sinclair
G. forbesi (King) Warb. Var. crassinervis (Warb.) J. Sinclair

Horsfieldia bracheata (King) Warb. Var. sumatrana (Miq.) J. Sinclair
H. bracteosa Hend. Var. microcarpa J. Sinclair
H. crassifolia (Hk.f. et Th.) Warb.
H. glabra (Bl.) Warb.
H. montana Airy Shaw
H. polyspherula (Hook.f. emend. King) J. Sinclair

Knema ashtonii J. Sinclair
K. cinerea (Poir.) Warb. var. alpina J. Sinclair
K. cinerea (Poir.) Warb. var. cinerea
K. cinerea (Poir.) Warb. var. sumatrana (Miq.) J. Sinclair
K. curtisii (King) Warb.
K. elmeri Merr.
K. furfuracea (Hk.f. et Th.) Warb.
K. intermedia (Bl.) King
K. kinabaluensis J. Sinclair
K. kunstleri (King.) Warb. var. kunstleri
K. latericia Elmer var. albifolia J. Sinclair
K. latericia Elmer var. latericia
K. latericia Elmer var.morindifolia (Bl.) J. Sinclair
K. laurina (Bl.) Warb.
K. percoriacea J. Sinclair
Myristica cinnamomea King
M. malaccensis Hook.f.
M. villosa Warb.

MYRSINACEAE
Ardisia colorata Roxb.
A. copelandii Mez.
A.bungoensis Furtado (ined.)
A. fuliginosa Bl.
A. hewitii Furtado (ined.)
A. hosei Mez.
A. javanica DC.
A. lanceifolia Merr.
A. macrophylla Reinw. Ex Bl.
A. obovatifolia Merr.
A. pyramidalis (Cav.) Per ex. A. DC.
A. tuberculata Wall. ex DC.

Myrsine affinis A. DC.
M. borneensis Scheff.
M. sp. nov.

MYRTACEAE
Decaspermum fruticosum Forst.

Eugenia acuminatissima Kurz
E. adenophylla Merr. & Perry
E. alcinae Merr.
E. anisosepala Duthie
E. aphanomyrtoides Merr. & Perry
E. astromoides C.B. Rob.
E. attenuata (Miq.) Koord. & Val.
E. bankensis (Hassk.) Backer
E. barringtonioides Ridl.
E. beccarii Ridl.
E. castanea Merr.
E. caudatilimba Merr.
E. cerina Hend.
E. chlorantha Duthie
E. chrysantha Merr. & Perry
E. corymbifera K. et V.
E. curtisii King
E. densiflora (Bl.) DC.
E. elliptilimba Merr.
E. fastigiata K. et V.
E. glanduligera Ridl.
E. grandis Wight
E. havilandii Merr.
E. heteroclados Merr.
E. hirta Korth.
E. kinabaluensis Stapf
E. kunstleri King
E. leucoxylon (Korth.) Miq.
E. lineata (Bl.) Duthie
E. monatha Merr.
E. multibracteolata Merr.
E. napiformis K. et V.
E. nemestrina Hend.
E. nitida Korth.
E. oblata Roxb.
E. ochneocarpa Merr.
E. ovatifolia Merr. & Perry
E. palawaensis C.B. Rob.
E. palembanica (Miq.) Merr.
E. punctilimba Merr.

E. rhynchophylla Merr.
E. rosulenta Ridl.
E. quadribracheata Hend.
E. steenisii Merr. & Perry
E. subdecussata Duthie
E. subrufa King
E. tawaensis Merr.
E. villamilii Merr.
E. viridifolia Elm.
E. zeylanica (L.) Wight

Leptospermum flavescens Sm.

Rhodamnia cinerea Jack

Tristania bilocularis Stapf
T. beccarii Ridl.
T. clementis Merr.
T. obovata R. Br.
T. whiteana Griff.

Whiteodendron moultonianum
(W.W. Sm.) V. Steenis

Xanthomyrtus flavida (Stapf) Merr.

NEPENTHACEAE

Nepenthes ampullaria Jack
N. bicalcarata Hook.f.
N. fusca Dansar
N. gracilis Korth.
N. lowii Hook.f.
N. muluensis M. Hotta
N. rafflesiana Jack
N. stenophylla Merr.
N. tentaculata Hook.f.
N. veitchii Hook.f.

NYMPHAEACEAE

Barclaya motleyi Hook.

OCHNACEAE

Euthemis laucocarpa Jack
E. minor Jack

Gomphia serrata (Gaertn.) Kanis

Neckia serrata Korth.

OLACACEAE
Ochanostachys amentacea Mast.

Scorodocarpus borneensis Becc.

Strombosia aff. Javanica Bl.
S. latifolia Stapf
S. rotundifolia King

OLEACEAE

Jasminium crassifolium Bl.

Linociera cuspidata (Bl.) Knobl.
L. evenia Stapf
L. oligantha Merr.
L. pluriflora Knobl.
L. ramiflora (Rixb.) Koord.
L. spicifera Ridl.
L. sp. 'A'
L. sp. (S24,925)

Myxophyrum inerve Steen.
Olea sp. (S26,535)

PIPERACEAE
Piper arborescens Roxb. Var. arboroscens
P. arborescens Roxb. Var. hirtellum
(Miq.) Merr.
P. aff. caninum Bl.
P. kurzii Ridl.
P. muricatum Bl.
P. porphyrophyllum N. E. Br.
P. ramifolium C. DC.
P. vestitum C. DC.
POLYGALACEAE

Epirixanthes cylindrica Bl.
E. elongata Bl.

Polygala venenosa Juss. Ex. Poir.

Xanthophyllum cordatum Korth
ex. Miq.
X. discolor Chodat
X. ecarinatum Chodat
X. ellipticum Korth. Ex. Miq.
X. ellipticum Korth. Ex Miq. Var.
subcoriaceum
X. ferrugineum Meijden
X. flavescens Roxb.
X. macrophyllum Baker

X. ovatifolium Chodat
X. stipitatum Benn.
X. subcoriaceum (Chodat) Meijden

PROTEACEAE

Helicia fuscotomentosa Suess.
H. petiolaris Benn.
H. robusta (Roxb.) R. Br. Ex. Wall.

RAFFLESIACEAE
Rhizanthes sp.

RANUNCULACESE
Clematis smilacifolia Wall.

RHAMNACEAE
Alphitonia moluccana T. & B.

Rhamnus nepalensis Laws.

Zizyphus grewioides (Ward.) Perry
Z. horsfieldii Miq.

RHIZOPHORACEAE
Anisophyllea corneri Ding Hou
Carallia brachiata (Lour.) Merr.
C. borneensis Oliv.
C. coriifolia Ridl.

Combretocarpus rotundatus (Miq.) Danser

ROSACEAE

Acioa heteropetala Kost.
Licania splendens (Korth.) Prance et Kost.
Parastemon spicatum Ridl.
P. urophyllum (A. DC.) A. DC.

Parinafri sp. (S8,010)

Prunus arborea (Bl.) Kalkm. Var. arborea
P. arborea (Bl.) Kalkm. var. densa (King.) Kalkm.
P. arborea (Bl.) Kalkm. var. stipulacea (King.) Kalkm.
P. oocarpa (Stapf) Kalkm.
P. turfosa Kalkm.

Rubus glomeratus Bl.
R. moluccanus L.

RUBIACEAE
Acranthera frutescens Val.
A. involucrata Val.

Anthocephalus cadambe (Roxb.) Miq.

Argostemma brachyantherum Stapf
A. borragineum Bl.
A. elatostemma Maingay ex. Hook.f. forma obovatum King
A. gracile Stapf
A. haemeliaefolia Wernh.
A. havilandii Ridl.
A. ophirense Maingay ex. Hook.f.
A. parvifolia Benn. var. involucratum (Hemsl.) Bakh.f.
A. psychotrioides Ridl.

Canthium confertum Korth.
C. didymum Gaertn.f.

Cephalis stipulaceae Bl.

Gardenia tubifera Wall.

Hedyotis rigida (Bl.) Miq.
Hydnophytum formicarium Jack

Ixora bavica Brem.
I. flagrans Brem.
I. grandifolia Zoll. et. Mor.
I. griffithii Hook.

Lasianthus constrictus Wight
L. robinsonii Ridl.
L. stipularis Bl.

Lucianaea nervulosa Stapf

Maschalocorymbus sp.

Mitreola sphaerocarpa Leenh.

Mussaendopsis beccariana Baill.

Mycetia javanica (Bl.) Korth.

Myrioneuron cyaneum Hall.

Myrmecodia tuberosa Jack

Nauclea subdita (Korth.) Merr.
Neonauclea peduncularis Walp. Ex. G. Don.
N. strigosa Korth.

Ophiorrhiza jibrillosa Ridl.
O. communis Ridl.

Pleiocarpidia cephalotes (Ridl.) Brem.
P. sendahanica Brem.

Porterandia anisophylla
(Jack ex. Rixb.) Ridl.

Prarevinia borneensis (Mer.) Brem.
P. serichotricha Brem.

Prismatomeris lepidophloia (Miq.) Ridl.
P. tetrandera (Roxb.) K. Sch.

Psychotria crassifolia Miq.
P. elegans Ridl.
P. elmeri Merr.
P. laxiflora Bl.
P. nieuwenhuisii Val.
P. pachyphylla Ridl.

Randia kuchingensis W.W. Sm.
R. sp. 'A'

Rennellia speciosa Hook.f.

Steenisia pterosepala (Airy Shaw)
Bakh.f.

Streblosa bracteata Ridl.

Tarenna cumingiana (Vidal) Elmer

Timonius compressicaulis (Miq.) Boerl.
T. eskerianus W.W. Sm.
T. flavescens (Jack) Baker
T. lasianthoides Val.
T. matangensis Val.

Uncaria ferrea DC.

Urophyllum arboreum Korth.
U. congestiflorum Ridl.
U. neriifolium Ridl.
U. nigricans Wernh.
U. pellacalyx Ridl.
U. salicifolium Stapf
U. woodii Merr.

Xanthopytum involucratum Merr.

RUTACEAE
Acronychia porteri Hook.f.

Euodia punctata Merr.

Lunasia amara Blanco

Meliocope minutum (Forst.f.) W. & A.

Pleiospermum latiolatum Swingle

Tetractomia sp. (B. 1174)

SABIACEAE
Meliosma rufo-pilosa Hend.
M. sumatrana (Jack) Walp.

SANTALACEAE

Dendrotrophe buxifolia (Bl.) Merr.
D. varians (Bl.) Miq.

Scleropyrum wallichianum
(W. et A.) Arm.

SAPINCADEAE
Allophyllus cobbe (L.) Rausch.

Arytera littoralis Bl.

Dimocarpus longan Lour. Var. malensiana
Leenh.

Guioa bijuga (Hiern) Radlk.
G. pubersens (Zoll. et Mor.) Radlk.

Harpullia arborea (Blanco) Radlk.

Lepisanthes amoena (Hassk.) Leenh.
L. fruticosa (Roxb.) Leenh.
L. tetraphylla (Vahl.) Radlk.

Mischocarpus sp. (FRI 20,336)

Nephelium lappaceum L.
N. maingayi Hiern
N. Mutabile Bl.
N. uncinatum Radlk.
Paranephelium nitidum King

Pometia pinnata Forst. Var. alnifolia
(Hook.f.) Jacobs

Tritiropsis ferruginea Leenh.

Xerospermum intermedium Radlk.

SAPOTACEAE

Ganua kingiana (Brace) v.d. Assen
G. palembanica (Miq.) v.d. Assen et Kost.
G. prolixa Pierre ex. Dubard

Isonandra lanceolata Wight var. lanceolata
Muduca korthalsii (Pierre) H.J. Lam
M. kunstleri (Brace) H.J. LamM.
M. malaccensis (C.B. Cl.) H.J. Lam
M. sandakanensis van Royen

Momosops elengi L.

Palaquium decurrens H.J. Lam
P. gutta (Hook.f.) Baill.
P. leiocarpum Boerl.
P. longipedicellata Pierre
P. pseudocuneatum H.J. Lam
P. pseudorostratum H.J. Lam
P. ridleyi King et Gamble
P. rioense H.J. Lam
P. rostratum (Miq.) Burck
P. sericeum H.J. Lam
P. stipulare Pierre ex Dubard
P. walsuraefolium Pierre ex Dubard

Payena lucida (G. Don.) DC.
P. obscura Burck

Planchonella obovata (R. Br.) Pierre

Pouteria malaccensis (Clarke) Baehni

SAURAUIACEAE
Saurauia acuminata Merr.
S. heterosepala Merr.
S. horrida Hook.f. var adpressa Airy Shaw
S. rheinwardtia Bl.

SIMAROUBACEAE
Eurycoma longifolia Jack

Picrasma javanica Bl.

SOLANACEAE
Lycianthes biflora (Lour.) Coom.

SONNERATIACEAE
Duabanga moluccana Bl.

STAPHYLEACEAE
Erythroxylon cuneatum Kurz

Turpinia latifolia Hassk.
T. sphaerocarpa Hassk.

STERCULIACEAE
Firmiana malayana Kost.

Heritiera albiflora (Ridl.) Kost.
H. elata Ridl.
H. simplicifolia (Mast.) Kost.

Leptonychia heteroclita (Roxb.) Kurz

Pterospermum javanicum Jungh.
P. subpeltatum C.B. Rob.

Scaphium borneensis (Merr.) Kost.

Sterculia rubiginosa Vent.

SYMPLOCACEAE
Symplocos crassipes Clarke var. ernae (Brand.) Noot.
S. fasciculata (Wall.) Zoll.
S. odoratissima (Bl.) Choisy ex Zoll.
S. pendula Wight var. confusa (Brand.) Noot.

TETRAMERISTACEAE
?Tetramerista glabra Miq.

THEACEAE
Adinandra acuminata Korth.
A. clemensiae Kobuski
A. cordifolia Ridl.
A. dasyantha Korth.
A. dumosa Jack
A. sarcosanthera Miq.
A. sp. (S3,876)

Cordyoblaste sp. 'A'
C. sp. 'B'

Gordonia havilandii Burkill

G. lanceifolia Burkill

Schima wallichii (DC.) Korth.

Ternstroemia aneura Miq.
T. beccarii Stapf ex Ridl.
T. denticulata (Pierre) Ridl.
T. macrocalyx Airy Shaw
T. magnifica Stapf ex Ridl.

THYMELAEACEAE

Amyxa pluricornis (Radlk.) Domke

Aquilaria microcarpa Lamk.

Wikstroemia indica (L.) C.A. Mey.
W. tenuiramis Miq.

TILIACEAE
Brownlowia glabrata Stapf ex. Ridl.
B. peltata Benth.

Grewia cinnamomifolia Stapf. ex. Burret
G. fibrocarpa Mast.
G. latifolia Mast.
G. omphacarpa Miq.
G. paniculata Roxb.

Pentace corneri Kost.
P. rigida Kost.

TRIGONIACEAE
Trigoniastrum hypoleucum Miq.

ULMACEAE
Gironniera nervosa Planch.
G. subaequalis Planch.

URTICACEAE
Boehmeria malabarica Wedd.

Dendrocnide stimulans (Linn.f.) Chew
Elatostema acuminata (Poir) Brongn.
E. variolaminosum Schr. var. latum
E. sesquifolium (Bl.) Hassk.

Leucosyke capitellata (Poir) Wedd.

Pilea calcarea Ridl.
P. fruticosa Hook.f.

Pipturus argenteus (Forst.) Wedd.
P. repandus Bl.
Poikilospermum cordifolium (B & P) Merr.
P. oblongifolium Merr.
P. scabrinervium Merr.

VERBENACEAE
Callicarpa involucrata Merr.

Clerodendrum myrmecophilum Ridl.
C. squamatum Vahl

Hoseanthus lobbii (Cl.) Ridl.

Petraeovitex sp.

Teijsmanniodendron glabrum Merr.
T. hollrungii (Warb.) Kost.
T. pteropodum (Miq.) Bakh.
T. sarawakanum (pears.) Kost.

Vitax pubescens Vahl

VIOLACEAE
Rinorea bengalensis (Wall.) O.K.
R. horneri (Korth.) O.K.

VITIDACEAE
Pterisanthes polita (Miq.) Planch.

Vitis cinnamomea Wall.

WINTERACEAE
Drimys piperita Hook.f.

Illicium kinabaluense A.C. Smith
I. stapfii Merr.

Gymnosperms

PODOCARPACEAE

Dacrydium falciforme (Parl.) Pilg.

GNETACEAE
Gnetum cuspidatum Bl.

Antiosperms

Monocotyledons

ARACEAE
Aridarum caulescens M. Hotta
Bucephalandra motleyana Schoott

CYPERACEAE
Carex sp. probably cruciata Wahlenb.
Carex dietrichiae Boeck
Carex indica L.
Carex perakensis C.B. Clarke var.
borneensis (C.B. Clarke) Noot.
Mapania monostachya Uitt.
Paramapania radians
(C.B. Ckarje) Uitt.

GRAMINEAE
Cyrtococcum accerescens (Trin.) Stapf
Digitaria setigera Roth ex Roem.
And Schult.

ORCHIDACEAE

Perpedilum sandersonii
Calanthe cf. Pulchara

PALMAE

Areca dayung Dransfield
Calamus ?jaherianus Becc.
C. leloi Dransfield
C. lobbianus Becc.
C. ornatus Bl.
C. paspalanthus Becc.
C. pogonacanthus Becc.
C. scipionum Lour.
C. sordidus Dransfield
Daemonorops collarifera Becc.
D. pseudomirabillis Becc.
D. sp. cf. Cymbospatha
Licuala aff. Olivifera Becc.
L. aff. orbicularis Becc.
Pinanga veitchii H. Wendl.
Plectocomiopsis geminiflorus
(Griff.) Becc.
Salacca vermicularis Becc.

PANDANACEAE
Freycinetia cf. Kalimantanica Stone
Pandanus sp. nov.

Dicotyledons

ACANTHACEAE

Hallieracantha aff. Creaghii Stapf.

ANACARDIACEAE
Dracontomelon costatum Bl.

ANNONACEAE
Pyramidathe cf. Prismatica
(Hk. f.) Sinclair

APOCYNACEAE
Alyxia lucida Wall.
Ervatamia sphaerocarpa

ARALIACEAE

Aralidium pinnatifolium Miq.
Arthrophyllum diversifolium Bl.
Schefflera beccariana Horms.
S. aff. longifructescens Elm.
S. lucida (King) Ridl.
Osmoxylon (Boerlagiodendron) sp.

ARISTOLOCHIACEAE

Thottea sp.

BALANOPHORACEAE
Balanophora elongata Blume

BEGONIACEAE
Begonia congesta Ridl.

BIGNONIACEAE
Deplanchea glabra v. Steenis

BOMBACEAE
Durio grandiflorus (mast.) Kost.
Ex Soep.

BURSERACEAE
Canarium caudatum King f. caudatum
C. merillii H.J. Lam

CELASTRACEAE
Kokoona ovatolanceolata Ridl.

COMPOSITAE
Gynura albicaulis W. W. Sm.

CONVOLVULACEAE
Jacquemonita tomentella (Miq.)
Hall. f. var. tomentosa va. Oestr.

DILLENIACEAE
Dillenia excelsa (Jack) Gilg.Var. pubescen
(Corner) Corner ex Masanne

ELAEOCARPACEAE
Elaeocarpus beccarii A.DC.

ERICACEA

Costera ovalifolia J.J. Sm.
Diplycosia scabrida Becc.
Vaccinium borneense W.W.Sm.
V. sulcatum Ridl.

ERYTHROXYLACEAE

Erythroxylum cuneatum (Miq.) Kurz.

EUPHORBIACEAE
Antidesma atatum Hk.f.
Euphorbia sp. probably sp. nov ?aff.
E. luzoniensis Merr.
Glochidion sericeum (Bl.) Zoll
Macaranga anceps Airy Shaw ssp.
puncticulata Whitmore
M. calicola Airy Shaw
M.hypoleuca Muell.
M. kingii Hook f. var. platyphylla
M. trachyphylla Airy Shaw
Mallotus macrostachyus (Miq.)
Muell. Arg.
M. oblongifolius (Miq.) Muell-Arg.
Phyllanthus chamaepeuce Ridley
Ptychopyxis of. Caput-medusae Miq.
Suregade multiflora Juss.

FAFACEAE
Lithocarpus nieuwenhuisii (v. Steen)
A. Camus

FLACOURTIACEAE
Ryparosa javanica (Bl.) Kurs

GESNERIACEAE
Cyrtandra splendens C.B. Clarke
Monophyllaea andersonii B.L. Burtt
M. cupiflora B.L. Burtt
var. aggregata B.L. Burtt
M. cupiflora B.L. Burtt
var. cupiflora
M. fissilis B.L. Burtt
M. hottae B.L. Burtt
M. insiginis B.L. Burtt
var. insiginis
M. insiginis B.L. Burtt
var. rubriflora B.L. Burtt
M. merrilliana Kraenzlin
M. pendula B.L. Burtt

GONYSTYLACEAE
Gonystylus borneensis Airy Shaw

LABIATAE
Gomphostemma microcalyx Prain

LAURACEAE
Cinnamimum caudifolium Kosterm.

LEGUMINOSAE
Cassia alata L.
Mezoneurum sumatranum (Roxb.)
Wight and Am.

LENTIBULARIACEAE
Utricularia striatula

LORANTHACEAE
Dendropthoe falcata Bl.
Lepidaria bicarnata Van Tieghem

MELASTOMATACEAE
Anerincleistus ovatus

Dissochaeta glandulosa Merr.
Kilbessia korthalsiana Cogn.
Marumia pachygyna Korth
Medinilla robusta Cogn.
M. scandens King
Melastoma decemfidum Roxb.
Memecylon cephalanthum Ridley
Neodriessenia sp.
Ochthocharis sp.
Pachycentria microsperma Becc.
P. tuberculata Korth
Pomatostoma sertuliferum (Becc.) Stapf.
Tayloriphyton glabrum

MELIACEAE
Aglaia shawiana
Sandoricum borneense Miq.

MORACEAE
Ficus chartacea Wall ex King
F. deltoidea Jack var. borneensis
F. deltoidea Jack var. deltoidea
F. heteropleura Bl.
F. paracamptophylla Corner
F. spathulifolia Corner
F. spiralis Corner

MYRISTICACEAE
Horsfieldia sabulosa J. Sinol.
Knema galeata J. Sinc.
K. latifolia Warb.
Myristica crassa King

MYRSINACEAE
Ardisia fortis Mez.
Labisia pumila (Bl.) Benth. Et. Hk. f.

MYRTACEAE
Eugenia sarawacense Merr.

OLACACEAE
Olax sp.

PIPERACEAE
Peperomia sp.

POLYGALACEAE
Xanthophyllum graffithii Hook.
F. ex. Benn.

RHAMNACEAE
Zizyphus havilandii Ridl.
Anisophyllaea disticha
A. ferruginea Ding Hou

RHIZOPHOREAE
Anisophyllaea disticha
A ferruginea Ding Hou

RUBIACEAE
Acranthera aff. Longepetiolata Merr.
Argostemma ?aff. inaeguale Benn.
Chassalia curviflora Thw.
Diplospora beccariana King
Gaertnera vaginans (DC.) Merr. Subsp.
Junghuhniana (Miq.) van beusekom
Geophila (L.) Pearsan
Gonyanera sp.
Ixora cf. Brachyanthera Brem.
Ixoraaff. Caudata Brem.
I. glomeruliflora Brem.
I. lancisepala Ridley
I. polycephala Brem.
I. cf. pyrantha Brem.
Lasianthus aff. Borneensis Merr.
L. gracilips Ridley
L. griffithii Wight
L. inaegualis Bl.
L. longifolius Wight
L. maingayi Hook f.
L. pilosus Wight
L inociera cuspida (Bl.)
Lucianaea membranacea King
L. pentacme Stapf.
L. ridleyi King
Myrmeconauclea strigosa (Korth) Merr.
Naulea calycina Bartt.
N. synkorynos Korth
Ophiorrhiza axillaris Ridl.
O. havilandii Ridl.
O. winkleri Val.
Pavetta axillaris Brem.
P. cf.. mirabilis Brem.
P. petiolaris Craib ex Brem.
P. sarawacensis Brem.
Pleiocarpida enneandra (wright)
K. Schum
Proscephaleium sp aff.
Javanicum Korth
Psychotria densifolia stapf.
P. cf. iteophylla Stapf
P. sp. ? sarmentosa Bl.
Randia beccariana Baill.
R. longiflora Lam.
Rennellia ?elongata (King and
Gambley) Ridley
Streblosa cf. Myriocarpa Merr. Et
Clav. Bremekamp

Tarenna cf arboresum Ridley
T. crassifolia Ridl.
T. fragrans (Bl.) K. et Val.
Timonius borneensis Valeton
Uncaria acida (Hunt) Roxb.
U. cordata (Lour.) Merr. Var. ferruginea
(Bl.) Ridsdale f. insignis (Bart in
DC) Ridsdale
Urophyllum cf. Hirsutum Hook. F.
Xanthopphytum grandifolium
Valeton ex Bakh. f.

RUTACEAE
Luvunga crassifolia Tanaka
L. motleyi Oliver

SAPINDACEAE
Harpullia cupanioides Roxb.
Naphelium beccarianum Radk.

SAURAUIACEAE
Saurauia glabra Merr.

THEACEAE
Pyrennaria kunstleri King
Ternstroemia citrina

THYMELAEACEAE
Wikstroemia ovata L.A. Mey ex Meisch

TILIACEAE
Grewia ossea Burret

URTICACEAE
Poikilospermum suaveolens (Bl.) Merr.

VERBENACEAE
Gmelina uniflora Stapf
Premna oblongifolia Merr.
Teijsmanniodendron bogoriense Koord.
T.holophyllum (Backer) Kost.

VITIDACEAE
Cissus sp.
Tetrastigma pedunculare (Wall.) Planchon

A preliminary list of Pterridophytes collected in Gunung Mulu National Park. Determined by J.P. Croxall, R.E. Holttum, A. C. Jermy, B. S. Parris and J. M. Rankin, July 1979.

PSILOTACEAE
Psilotum complanatum Sw.
P. flaccidum Wall.

LYCOPODIACEAE
Lycopodium casuarinoides Spr.
L. cernuum L.
L. (aff) ceylanica Hieron.
L. dalhousieanum Spr.
L. laxum Presl
L. nummularifolium Bl.
L. phlegmaria L.
L. pinifolium Blume
L. serratum Thunb.
L. squarrosum Forst.
L. volubile Forst.

SELAGINELLACEAE
Selaginella alopecuriodes Bak.
S. alutacia Spr.
S. atroviridis (Wall. ex Hook.) & Grev.) Spr.
S. blumensis v.A.v.R
S. boschai Hieron
S. (aff) brevipes A.Br.
S. brooksii Hieron.
S. caulescens (Wall.) Spr.
S. dielsii Hieron.
S. hewittii Hieron.
S. humifusa Hieron.
S. intermedia (Bl.) Spr.
S. involvens (Sw.) Spr.
S. lobbii Veitch
S. longiaristata Hieron.
S. paxii Hieron
S. posewitzii Hieron.
S. rugulosa Ces.
S. subcalcarata V.A.V.R.
S. subserpentina V.A.V.R.

OPHIOGLOSSACEAE
Helminthostachys zeylandica (L.) Hook.
Ophioglossum pendulum L.
Macroglossum smithii (Racib.) Campbell
Christensenia aesculifolia (Bl.) Maxon

PLAGIOGYRIACEAE
Plagiogyria adnata (Bl.) Bedd.
P. pycnophylla (Kze.) Mett.
P. tuberculata Copel.

SCHIZAEACEAE
Schizaea dichotoma (L.) S.
S. digitata (L.) Sw.
S. malaccana Bak.
Lygodium borneense V.A.V.R.
L. circinnatum (Burm.) Sw.

PARKERIACEAE
Ceratopteris thalictriodes (L.) Brongn.

ADIANTACEAE
Gheilanthes farinosa (Forsk.) Klf.
Pityogramma calomelanos Link
Syngramma alismifolia (Presl) J. Sm.
S. quinata (Hook.) Carr. in Seem.
Taenitis blechnoides (Willd.) Sw
T. cordata (Gaud.) Holtt.
T. hookeri (C.Chr..) Holtt.
T. trilobata Holtt.
Adiantum hosei Bak.
A. malesianum Ghatak
Antropyum callifolium Bl.
A. parvulum Bl.
A. plicatum Bl.
A. reticulatum Klf.
A. semicostatum Bl.
A. subfalcatum Brack.
Vittaria angustifolia Bl.
V. elongata Sw.
V. ensiformis Sw.
V. longicoma Christ

MARATTIACEAE

Angiopteris evecta (Forst.) Hoffm.
A. subintegerrima V.A.V.R.
Marattia pellucida Presl
M. sylvatica Bl.
Pteris asperula J. Sm.
P. clenensiae Copel.
P. ensiformis Burm.
P. excelsa Gaud.
P. furcans Bak.
P. johanis-winkleri C. Chr.
P. longipinnula Wall. ex. Agardh
P. quadriaurita Retz.
P. scabripes Wall.
P. tripartita Sw.
P. vottata L.

HYMENOPHYLLACEAE

Microtrichomanes nitidulum (V.d.B.) Copel
M. palmatifidum (Muller) Copel.
Meringium acanthoides (v.d.B.) Copel.
M. bakeri (Copel.) Copel.
M. blandum (Racib.) Copel.
M. cardunculus (C.Chr. in Irmsch.) Copel.
M. denticulatum (Sw.) Copel.
M. holochilum (v.d.B.) Copel.
M. hosei (Copel.) Copel.
M. lobbii (Moore) Copel.
M. microchilum (Bak.) ined.
M. pachydermicum (Ces.) Copel.
M. penangianum (Matthes ex Christ) Copel.
Sphaerocionium pilosissimum (C.Chr.) Copel.
Mecodium badium (Hooker & Grev.) Copel.
M. emarginatum (Sw.) Copel.
M. javanicum (Spengel) Copel.
M. polyanthos (Sw.) Copel.
M. productum (kze.) Copel.
M. salakense (Racib.) Copel.
M. thuidium (Harr.) Copel.
Trichomanes maximum Bl.
Crepidomanes bipunctatum (Poir.) Copel.
C. christii (Copel.) Copel.
C. kurzii (Bedd.) ined.
C. perverulosum (V.A.V.R.) Copel.
C. sarawakense Iwat.
Reediella humilis (Forst.) Pic Ser.
Pleuromanes album (Bl.) ined.
P. pallilum (Bl.) Presl
Gonocormus vovoguineensis (Brause) Copel.
G. minutus (Bl.) v.d.B.
G. saxifragoides (Presl) v.d.B.
V. scolopendrina (Bory) Thwait
Monogramma dareicarpa Hook.
Vaginularila trichoidea (J. Sm.) Fee

Selenodesmium obscurum (Bl.) Copel.
S. saxatile (Moore) ined.
Marroglena idorea (Morton) ined.
M. meifolia (Bory ex Willd.) Copel.
M. setigera (Backh. Ex Moore)
M. schlecteri (Brause) Copel.
Cephalomanes javanicum (Bl.) v.d.B.
C. laciniatum (Roxb.) de Vol
C. singaporeanum v.d.B.
C. sumatranum (V.A.V.R.) Copel
Neosopteris grandis (Copel.) Copel.
N. superba (Backh.) ex Moore) Copel
Microgonium mindorense (Christ) Copel.
M. motleyi v.d.B.
M. sublimatum (Muller) v.d.B.

GLEICHENIACEAE

Gleichenia brevipinnula Holtt.
G. bullata Moore
G. hirta Bl. var. paleacea (Bak.) C.Chr.
G. longissima Bl.
G. norrisii Mett. In kuhn.
G. trucata (Willd.) Spr.
G. vulcanica Bl.
Dicranopteris linearis (Burm. f.)
Underw. Var. alternans (Mett.) Holtt.
D. linearis var. ferruginea (Bl.) Holtt.
D. linearis var. linearis
D. linearis var. montana Holtt.
D. linearis var. ridida (Bl.) Holtt.
D. speciosa (Presl) Holtt.

MATONAICEAE

Matonia pectinata R. Br.
Phanerosorus sarmentosus (Bak.) Copel.

CHEIROPLEURIACEAE

Cheiropleura bicuspis (Bl.) Presl

DIPTERIDACEAE

Dipteris conjugata Reinw.
D. lobbiana (Hook.) Moore
D. novoguinensis Posth.
D. quiquenfurcata (Bak.) Christ

POLYPODIACEAE

Drynaria sparsisora (Desv.) Moore
Photinopteris speciosa (Bl.) Presl
Platycerium coronarium (Konig) Desv.
Pyrrosia angustata (Sw.) Ching
P .christii (Giesenh.) Ching
P. nummularifolia (Sw.) Ching
P. varia (Klf.) Farwell
Microsorum commutatum (Bl.) Copel.
M. heterocarpum (Bl.) Ching
M. musifolium (Bl.) Ching
M. nigrescens (Bl.) Copel.
M. punctatum (L.) Copel
M. sarawakense (Bak.) Holtt.
M. scolopendria (Burm.f.) Ching
Colysis acuminata (Bak.) Holtt.
C. bolsteri (Copel.) Copel.
C. macrophylla (Bl.) Presl.
C. membranacea (Bl.) Presl

Pycnoloma metacoelum (V.A.V.R.) C. Chr.
Holocosorus setaceus (Copel.) Copel
Crypsinus albidopaleatus (Copel.) Copel.
C. albidosquamatus (Bl.) Copel.
C. enervis (Car.) Copel
C. platyphyllus (Sw.) Copel.
C. stenophyllus (Bl.) Holtt.
C. stenopteris (Bak.) ined.
C. taeniatus (Sw.) Copel. var.
borneensis (Chris) Tagawa.
C. taeniatus var. taeniatus
C. trilobus (Houtt.) Copel.
Selli guea heterocarpa Bl.
S. lima (V.A.V.R.) Holtt.
S. treubii (christ) Ching
Polypodiopteris brachypodia (Copel.) Reed
Lemmaphyllum accedens *Bl.) Donk
Paragramma longifolia (Bl.) Moore
Belvisia mucronata (Fee) Copel.
B. revoluta (Bl.) Copel.
Polypodium leucophorum Bak.
P. verrucosum (Hk.) Wall. ex Hk.
Gonioplebion matripitense (C. Chr.) ined.
G. rajaense (C. Chr.) ined.
G. subauriculatum (Bl.) Presl
Thylacopteris papillosa Kze.

GRAMMITIDACEAE

Grammitis bongoensis)Copel.) Copel.
G. frederici-et-pauli (Christ) Copel.
G. impressa Copel.
G. jagoriana (Mett. ex. Kuhn) Tagawa
G. knutsfordiana (Bak.) Copel.
G. maxwellii (Bak.) Parris (ined.)
G. reinwardtii Bl.
G. reinwardtioides Copel.
G. setosa Bl.
G. sparsipila (Copel.) Parris (ined.)
G. sumatrana (Bak.) Copel.
G. vittariifolia (C. Chr.) Parris (ined.)
Xiphopteris bryophylla (V.A.V.R.) Parris (ined.)
X. hieronymusii (C. Chr.) Holtt
Ctenopteris barathrophylla (Bak.) Parris (ined.)
C. brevivenosa (V.A.V.R.) Holtt
C. celebica (Bl.) Copel.
C. mollicoma (Nees & Bl.) Kze.
C. moultoni (Copel.) Holtt.
C. nutans (Bl.) J. Sm.
C. verulosa (Bl.) Kze.
Calymmodon cucullarus (Nees & Bl.) Presl
C. Gracilis (Fee) Copel.
C. hyalinus Copel.
Acrosorus streptophyllus (Bak.) Copel.
A. triangularis (Scort. ex Bedd Copel.
Prosaptia altata (Bl.) Christ
P. contigua (Forst.) Presl
Scleroglossum crassifolium (Bak C. Chr.
S. pusillum (Bl.) V.A.V.R
Loxogramme antrophyoides (Bak.) C. Chr.

L. forbesii Copel.
L. nidiformis C. Chr.
L. scolopendrioides (Gaud.) Morton

CYATHEACEAE

Cyathea assimilis Hook.
C. borneensis Copel.
C. glabra (Bl.) Copel.
C. latebrosa (Wall. ex Hook.) Copel
C. leucotriacha Chris
C. moluccana R. Br. ex. Desv.
C. polypoda Bak.
C. ramispina (Hook.) Copel.
C. recommutata Copel.
C. squamulata (Bl.) Copel.
Cystpdium sorbifolium (Sm.) J. S.

THYRSOPTERRIDACEAE
Cibotium barometz (L.) J. Sm
C. cumingii Kze.

DENNSTAEDTIACEAE
Dennstaedtia glabrata (Ces.) C. Chr.
D. scarra (Wall.) ex Hook.)
Moore var. tenuisecta C. Chr.
D. smithii (Hook.) Moore
Microlepia manilensis (Goldm.) Presl ex Prantl
M. puberula V.A.V.R
M. speluncae (L.) Moore var.
Villosissima C.Chr.
Pteridium esculentum (Forst.) Nakai
Histiopteris incisa (Thunb.) J. Sm.

H. stipulacea (Hook.) Copel.
Lindsaea bornensis Hook. Ex Bak.
L. bouilldodii Chris
L. crispa Bak.
L. divergens Hook. & Grev.
L. doryphora Kramer

L. integra Holtt.
L. lobata Poir
L. lucida Bl. ssp. lucida
L. malayensis Holtt.
L. obtusa J. Sm.
L. ovata J. Sm. in Hook.
L. parallelogramma V.A.V.R.
L. repens (Bory) Thwait. Var. pectinata
(Bl.) Mett. Ex Kuhn
L. repens var. sessilis (Copel.) Kramer
L. rigida J. Sm. ex Hook.
L. sarawakensis Kramer
L. walkerae Hook.
Sphenomeris chinesis (L.) Maxon
S. veitchii (Bak.) C. Chr.
Tapeinidium luzonicum (Hook.)
Kramer var. luzonicum
T. pinnatum (Cav.) c. Chr.
Xyropteris stortii (V.A.V.R.) Kramer

THELYPTERIDACEAE
Coryphopteris andersonii Holtt.
C. badia (V.A.V.R.) Holtt.
C. multisora (C. Chr.) Holtt.
C. viscosa var. viscosa
Macrothelpteris torresiana (Gaud.) Holtt.
Pronephrium borneense (Hook.) Holtt.
P. firmulum Holtt.
P. glandulosum (Bl.) Holtt.
P. hosei (Bak.) Holtt.
P. menisciicarpon (Bl.) Holtt.
P. nitidum Holtt.
P. peltatum (V.A.V.R) Holtt. var. aberrrans
Holtt. (ined.)
P. peltatum var. persetiferum Holtt. (ined.)
P. salicifolium (Wall. ex Hook.) Holtt.
P. simillium (C. Chr.) Holtt.
P. thysanoides Holtt. (ined.)
Mesophlebion beccarianum (Ces.) Holtt.
M. chlamydophorum (Rosenst.) Holtt.
M. crassifolium (Bl.) Holtt.
M. dulitense Holtt.
M. falcatilobum Holtt. (ined.)
M. falcatilobum Holtt. var. apiculatum
Holtt. (ined.)
M. motleyanum (Hook.) Holtt.
M. oligodictyon (Bak.) Holtt.
M. trichopodum (C. Chr.) Holtt.
Plesioneuron medusella Holtt.
Chingia clavipilosa Holtt.
Sphaerostephanos baramensis (C. Chr.)
Holtt. (ined.)
S. caulescens Holtt. (ined.)
S. heteroscarpus (Bl.) Holtt.
S. heterocarpus var. borneensis Holtt. (ined.)
S. heterocarpus var. calcicola Holtt. (ined.)
S. hispidifolius (V.A.V.R.) Holtt.
S. inconspicuus (Copel.) Holtt.
S. latebrosus (Kze. Ex Mett.) Holtt.
S. muluensis Holtt. (ined.)
S. perglanduliferus Holtt. (ined.)
S. porphyricola (Copel.) Holtt.
S. pterosporus (V.A.V.R.) Holtt. var.
crenatus Holtt (ined.)
S. reconditus Holtt. (ined.)
S. trichochlamys Holtt. (ined.)
Pneumatopteris brooksii (Copel.) Holtt.
P. callosa (Bl.) Nakai
P. eburnea Holtt. (ined.)
P. psilophylla Holtt. (ined.)
P. truncata (Poir.) Holtt.
Christella hispidula (Decne) Holt.
C. subpubecens (Bl.) Holtt. (ined.)
Amphineuron immersum (Bl.) Holtt. (ined.)
A. paraphysophorum (V.A.V.R.) Holtt.

ASPLENIACEAE
Asplencium affine Sw.
A. affine var. amaurolobum (Rosenst.) ined.
A. baduense V.A.V.R.
A. borneense Hook.

A. colubrinum Crist
A. dichotomum Hook.
A. macrophyllum Sw.
A. nidus L. var. Nidus
A. pellucidum Lam.
A. phyllitidis ssp. malesicum Holtt.
A. salignum Bl.
A. scolopendroides J. Sm.
A. squamulatum Bl.
A. tenerum Forst.
A. thunbergii Kze.
A. unilaterale Lam.

DRYOPTERIDACEAE
Athyrium anisopterum Christ
Diplazium angusgisquamatum (Holtt.) ined.
D. bantamense Bl.
D. cordifolium (Bl.) Copel.
D. crenatoserratum (Bl.) Moore
D. crinitum (Bak.) C. Chr.
D. dilatatum Bl.
D. esculentum (Retz) Sw.
D. falcinellum C. Chr.
D. hewittii (Copel.) C. Chr.
D. hottae Tagawa
D. latisquamatum (Holtt.) Holtt.
D. malaccense Pr.
D. maximum (Don.) C. Chr.
D. megistophyllum Copel.
D. moultoni (Copel.) Tagawa
D. pallidum (Bl.) Moore
D. pariens (Copel.) C. Chr.
D. poiense C. Chr.
D. polycarpum (Copel.)
D. porphyrorachis (Bak.) Diels
D. riparium Holtt.
D. sorzogonense (Presl) Wilde
D. speciosum Bl..
D. tomentosum Bl.
Cystopteris tenuisecta (Bl.) Mett.
Hypodematium crenatum (Forsk.) Kuhn
Pleocnemia hemiteliiformis (Racib.) Holtt.
P. irregularis (Presl) Holtt.
P. olivacea (Copel.) Holtt.
Pteridrys acutissima Ching
P. microthecia (Fee) C.Chr. & Ching
Tectaria angula (Willd.) C. Chr.
T. barberi (Hook.) Copel.
T. brooksii Copel.
T. labrusca (Hook.)Copel
T. lobbii (Hook.) Copel.
T. maingayi (Bak.) Copel.
T. melanorachis (Bak,) Copel.
T. nitens Copel.
T. polymorphs (Wall.) Copel.
T. pleisora (V.A.V.R.(C. Chr.
T. singaporiana (Wall.) Ching
T. ternata (Bak.) Copel.
Heterogonium aspidiodes Presl
H. pinnatum (Copel.) Holtt.
H. sagenioides (Mett.) Holtt.
H. saxicolum (Bl.) Holtt.
Cyclopeltis cumingiana Fee
Diacalpe aspidioides Bl.
Polystichum lindsaeifolium Ridley
P. microphyllum (Bl.) Presl
Arachniodes puncticulata (V.A.V.R.) Ching
A. tripinnata (Goldm.) Sledge
Dryopteris sparsa (Don) Kze.
D. subarborea (Bak.) C. Chr.
Acrophorus nodosus Presl
Stenolepia tristis (Bl.) V.A.V.R.)

LOMARIOPSIDACEAE
Bolbitis apprendiculata (Willd.) Iwats.
B. heteroclita (Presl) Ching
B. sinuata (Presl) Hennipman
B. virens (Hk. & Grev.) Schott
Teratophyllum aculeatum (Bl.) Mett. ex Kuhn
T. clemensiae Holtt.
Lomagramma brooksii Copel.
L. sinuata C. Chr.
Lomariopsis lineata (presl) Holtt
Elaphoglossum annamense C. Chr. & Tard.
E. blumeanum (Fee) J.Sm. var. blumeanum
E. heterolepium V.A.V.R.
E. melanostictum (Bl.) Moore
E. spongophyllum P.R. Bell
E. stenolepis Holtt.

DAVALLIACEAE
Humata heterophylla (Sm.) Desv.
H. parvula (Wall.) Mett.
H. repens (L. fil.) Diels
H. subvestita (C. Chr.) ined.
H. vestita (Bl.) Moore
Davallia lobbiana Moore
Davallodes borneense (Hook.) Copel

T. crenata Cav.
T. devexa (Kze.) Copel.
T. holttumii C. Chr.
T. ingewns (Atk.) Holtt.
D. burbidgia C. Chr.
Araiostegia hymenophylloides (Bl..) Copel.

Leucostegia immersa (wall. ex Hook.) Presl var. amplissima Christ
L. immersa var. immersa
L. pallida (Mett. ex Kuhn) Copel.
Oleandra colubrina (Blanco) Copel.
O. coriacea Copel.
O. oblanceolata Copel.
O. pistillaris (Sw.) C. Chr.
O. sibbaldii Grev.
Nephrolepsis davallioides Kze.
N. falcata (Cav.) C. Chr.
N. pilosula V.A.V.R.

BLENCHNACEAE
Blechnum borneense C. Chr.
B. finlaysonianum Wall.
B. orientale L.
B. vestitum (Bl.) Kuhn

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ddendum

SELAGINELLACEAE

Selaginella conferta Moore

THELYPTERIDACEAE

Coryphopteris viscosa (J.Sm.) Holtt. var. borneensis Holtt.

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442 species

APPENDIX 4 : MAMMALS RECORDED IN THE GUNUNG MULU NATIONAL PARK.

Mammals recorded within the Gunung Mulu National Park.
After the Earl of Cranbrook, 1982. Additions after L S. Hall, 1996 and D W. Gill1998.

INSECTIVORA, the insectivores

Echinosorex gymnurus	Moonrat
Hylomya suillus	Lesser Gymnure
Suncus etruscus	Savi's Pigmy Shrew
Crocidura monticola	Sunds Shrew
Tupaia montana	Mountain Treeshrew
T. picta	Painted Treeshrew
Dendrogale melanura	Smooth-tailed Treeshrew

DERMOPTERA, the colugos

Cynocephalus variegatus	Flying Lemur

PHOLIDOTA.

Manis javanica	Pangolin

CHIROPTERA, the bats

Pteropus vampyrus	Flying Fox
Cyanopterus brachyotis	Malaysian Fruit Bat
Balioncyteris maculata	Spotted-winged Fruit Bat
Aethalops alecto	Grey Fruit Bat
Penthetor lucasii	Dusky Fruit Bat
Rhinolophus borneensis	Borneo Horseshoe Bat
R. creaghi	Creagh's Horseshoe Bat
R. philippinensis	Philippine Horseshoe Bat
Coelops robinsoni	Lesser Tailess Horseshoe Bat
Hipposideros galeritus	Cantor's Roundleaf Horseshoe Bat
H. diadema	Diadem Roundleaf Horseshoe Bat
H. dyacorum	Dayak Roundleaf Bat
H. bicolor	Bicolored Roundleaf Bat
H. cervinus	Fawn Roundleaf Bat
Myotis horsfieldii	Horsfield's Bat
M. ater	Black Myotis
Philetor branchypterus	Short-winged Brown Bat
Murina cyclotis	Round-eared Tube-nose Bat
Chaerephon plicata	Wrinkled-lipped Bat
Eonycteris spelaca	Cave Nectar Bat
Macroglossus minimus	Long-Tongued Nectar Bat
Emballonura alecto	Greater Sheath-Tailed Bat
Megaderma spasma	Lesser False Vampire
Kerivoula papillosa	Papillose Wooly Bat
K. whiteheadi	Whitehead's Wooly Bat
Miniopterus australis	Lesser Bent-Winged Bat
Glischropus tylopus	Thick-Thumbed Pipistrelle
Cheiromeles torquatuss	Naked Bat

PRIMATES, the monkeys, apes and relatives

Tarsius bancanus	Western Tarsier
Presbytis hosei	Grey Leaf Monkey
P. rubicunda	Maroon Leaf Monkey
P. cristata	Silvered Leaf Monkey
Macaca fascicularis	Long-tailed Macaque
M. nemestrina	Pig-tailed Macaque
Hylobates muelleri	Bornean Gibbon
Nycticebus coucang	Slow Loris

RODENTIA, the rodents

Ratufa affinis	Giant Squirrel
Callosciurus prevostii	Prevost's Squirrel
C. baluensis	Kinabalu Squirrel
C. notatus	Plantain Squirrel
Sundasciurus hippurus	Horse-tailed Squirrel
S. jentinki	Jentink's Squirrel
Lariscus insignis	Three-striped Ground Squirrel
Dremomys everetti	Bornean Mountain Ground Squirrel
Exiliscriurus exilis	Plain Pigmy Squirrel
E. whiteheadi	Whitehead's Pigmy Squirrel
Rheithrosciurus macrotis	Tufted Ground Squirrel
Aeromys tephromelas	Black Giant Flying Squirrel
Rattus muelleri	Muller's Rat
R. infraluteus	Mountain Giant Rat
R. cremoriventer	Dark-tailed Tree Rat
R. surifer	Red Spiny Rat
R. whiteheadi	Whitehead's Rat
R. rapit	Mountain Long-tailed Rat
R. Sabanus	Long-tailed (Giant Rat)
Chiropodomys gliroides	Tree-mouse (unidentified)
Trichys lipura	Long-tailed Porcupine
Hysterix/Thecurus	Large Porcupines (not positively identified)

CARNIVORA, the carnivores

Helarctos malayanus	Sun Bear
Martes flavigula	Yellow-throated Marten
Lutra sp./Amblonyx	Otter (not positively identified)
Viverra tangalunga	Malay Civet
Paradoxurus hermaphroditus	Common Palm Civet
Arctictis binturong	Bearcat
Arctogalidia trivirgata	Three-striped Palm Civet
Hemigalus derbyanus	Banded Palm Civet
Herpestes sp.	Mongoose
Felis bengalensis	Leopard Cat

ARTIODACTYLA, the cloven-hoofed ungulates

Sus barbatus	Bearded Pig
Tragulus sp., cf. Javanicus	(Lesser) Mouse-deer
Muntiacus muntjak	Barking Deer
Cervus unicolor	Sambar Deer

81 species

APPENDIX 5 : THE BIRDS

Birds recorded within Gunung Mulu National Park, compiled by Lord Cranbrook; list dated June 1979. The order of species follow Smythies (1968), Birds of Borneo, 2nd edn. Oliver & Boyd, London.

Nomenclature has been updated to conform with present scientific conclusions.

PELECANIFROMES, the cormorants and allies

Anhinga melanogaster	Darter

ARDEIFORMES, the heron and storks

Butodides striatus	Little Green Heron
Goisakius melanolophus	Tiger Bittern
Ciconia stormi	Storm's Stork

FALCONIFORMES, the hawks and eagles

Macheiramphus alcinus	Bat Hawk
Pernis ptilorhyncus	Honey Buzzard
Haliastur indus	Brahminy Kite
Accipiter trivirgatus	Crested Goshawk
A. virgatus	Asiatic Sparrowhawk
Spizaetus alboniger	Blyth's Hawk Eagle
S. cf. Nanus	(Wallace's) Hawk Eagle
Ictinaetus malayensis	Black Eagle
Icthyophage humilis	Lesser Fish Eagle
Spilornis cheela	Crested Serpent Eagle
S. kinabaluensis	Kinabalu Serpent Eagle
Microhierax fringillarius	Black-thighed (Common) Falconet
Falco peregrinus	Peregrine Falcon

GALLIFORMES, the pheasants and partridges

Arborophila hyperytha	Red-breasted Tree Partridge
Melanoperdix nigra	Black Wood Partridge
Rollulus rouloul	Crested Green Wood Partridge
Haematortyx sanguiniceps	Crimson-headed Wood Partridge
Lophura arythroptthalma	Crestless Fireback Pheasant
L. ignita	Crested Fireback Pheasant
L. bulweri	Bulwer's Pheasant
Argusianus argus	Great Argus Pheasant

CHARADRIIFORMES, the gulls and waders

Actitis hypoleucos	Common Sandpiper

COLUMBIFORMES, the pigeons and doves

Treron capellei	Large Green Pigeon
T. curvirostra	Thick-billed Green Pigeon

Ptilinopus jambu	Jambu Fruit Pigeon
Ducula aenea	Green Imperial Pigeon
D. badia	Mountain Imperial Pigeon
Macropygia ruficeps	Little Cuckoo Dove
Chalcophaps indica	Emerald Dove

PSITTACIFROMES, the parrots

Loriculus galgulus	Malay Lorikeet

CUCLIFORMES, the cuckoos

Cuculus sparverioides	Large Hawk Cuckoo
C. ugax	Malayan Hawk Cuckoo
C. vagans	Moustached (Lesser) Hawk Cuckoo
C. micropterus	Indian Cuckoo
C. saturatus	Oriental Cuckoo
Cacomantis sonneratii	Banded Bay Cuckoo
C. variolosus	Fan-tailed Cuckoo
Surniculus lugubris	Drongo Cuckoo
Phaeniciphaeus diardi	Lesser Green-billed Malcoha
P. chlorophaeus	Raffles' Malcoha
P. sumatranus	Rufous-bellied Malcoha
P. javanicus	Red-billed Malcoha
P. curvirostris	Chestnut-breasted Malcoha
Centropus sinensis	Common Coucal
C. rectunguis	Short-toed Coucal
Carpococcyx radiceus	Ground Cuckoo

STRIGIFORMES, the nighjars and allies

Batrachostomus auritus	Large Frogmouth
B. sp.	Frogmouth

APODIFORMES, the swifts

Aerodramus vanikorensis	Mossy-nest Swiftlet
A. fuciphagus	Edible-nest Swiftlet
A. maximus	Black-nest Swiftlet
Collocalia esculenta	White-bellied Swiftlet
Rhaphidura leucopygialis	White-rumped Spine-tail Swift
Hirundapus giganteus	Malaysian Spine-tailed Swift
Hemiprocne longipennis	Crested Tree-swift
H. comata	White-whiskered Tree-swift

TROGONIFORMES, the trogons

Harpactes diardi	Liard's Trogon
H. kasumba	Red-naped Trogon
H. whiteheadi	Whitehead's Trogon
H. duvauceli	Scarlet-rumped Trogon
H. orrhophaeus	Cinnamon-rumped Trogon
H. oresdias	Orange-breasted Trogon

CORACIIFORMES, the roller and allies

Lacedo pulchella	Banded Kingfisher
Halcyon concreta	Chestnut-collared Kingfisher
H. pileata	Black-capped Kingfisher
Pelargopsis capensis	Stork-billed Kingfisher
Alcedo mininting	Deep Blue Kingfisher
A. euroyzona	Blue-banded Kingfisher
Ceyx erithacus (rufidorsus)	Forest Kingfisher
Nyctyotnis amictus	Red-bearded Bee-eater
Berenicornis comatus	White-crested Hornbill
Anorrhinus galeritus	Bushy-crested Hornbill
Rhyticeros corugatus	Wrinkled Hornbill
R. undulatus	Wreathed Hornbill
Anthracoceros malayanus	Black Hornbill
A. coronatus	Pied Hornbill
Buceros rhinoceros	Rhinoceros Hornbill
Rhinoplax vigil	Helmet Hornbill

PICIFORMES, the woodpeckers and allies

Calorhamphus fuliginosus	Brown Barbet
Megalaima chrysopogon	Gold-wiskered Barbet
M. rafflesi	Many-colored Barbet
M. mystacophanos	Gaudy Barbet
M. henricii	Yellow-crowned Barbet
M. pulcherrima	Golden-naped Barbet
M. monticola	Mountain Barbet
M. eximia	Black-throated Barbet
M. australis	Little Barbet
Sasia abnormis	Rufous Piculet
Picus puniceus	Crimson-winged Woodpecker
P. mentalis	Checker-throated Woodpecker
P. miniaceus	Banded Red Woodpecker
Celeus brachyurus	Rufous Woodpecker
Meiglyptes tristis	Fulvous-rumped Barred Woodpecker
M. tukki	Buff-necked Barred Woodpecker
Hemicircus concretus	Grey & Buff Woodpecker
Dinopium rafflesi	Olive-backed Three-toed Woodpecker
Muellericipus pulverulentus	Great Slaty Woodpecker
Blythipicus rubiginosus	Maroon Woodpecker
Rheinwardtipicus validus	Orange-backed Woodpecker

PASSERES, the passerine birds

Calyptomena viridis	Green Broadbill
C. hosei	Hose's Broadbill
C. whiteheadi	Whitehead's Broadbill
Psarisomus dalhousiae	Long-tailed Broadbill
Cymbirhynchus macrorhynchos	Black and Red Broadbill
Eurylaimus ochromalus	Black and Yellow Broadbill
E. javanicus	Banded Broadbill
Corydon sumatranus	Dusky Broadbill

Pitta arcuata	Blue-banded Pitta
P. granatina	Garnet Pitta
P. baudi	Blue-headed Pitta
Hirundo tahitica	Pacific Swallow
H. rustica	Barn Swallow
Motacilla caspica	Grey Wagtail
M. flava	Yellow Wagtail
Tephrodornis gularis	Hook-billed Greybird
Coracina larvata	Black-faces Greybird
C. fimbriata	Lesser Greybird
Hemipus hirundinaceus	Black-winged Flycatcher-Strike
H. picatus	Bar-winged Flycatcher Strike
Chlamydochaera jeffreyi	Black-breasted Triller
Pericrocotus solaris	Mountain Minivet
P. flammeus	Scarlet Minivet
Aegithina viridissima	Green Iora
Chloropsis cyanopogon	Lesser Green Leafbird
C. sonnerati	Greater Green Leafbird
C. cochinchinensis	Blue-winged Leafbird
Irena puella	Fairy Bluebird
Pycnonotus eutilotus	Crested Brown Bulbul
P. melanoleucos	Black and White Bulbul
P. atriceps	Black-headed Bulbul
P. squamatus	Scaly-breasted Bulbul
P. cyniventris	Grey-bellied Bulbul
P. zeylanicus	Yellow-crowned Bulbul
P. flavescens	Pale-faced Bulbul
P. plumosus	Large Olive Bulbul
P. brunneus	Red-eyed Brown Bulbul
P. simplex	Cream-vented (White-eyed) Brown Bulbul
P. erythropthalmus	Lesser Brown Bulbul
Criniger bress	Scrub (Olive White-throated) Bulbul
C. ochraceus	Brown White-throated Bulbul
C. phaeocephalus	Crestless White-throated Bulbul
C. finschii	Finsch's Bulbul
Setornis criniger	Hook-billed Bulbul
Hypsipetes criniger	Hairy-backed Bulbul
H. malaccensis	Streaked Bulbul
H. charlottae	Crested Olive Bulbul
H. flavala	Ashy Bulbul
Erithacus cyane	Siberian Blue Robin
Brachypteryx montana	Blue Shortwing
Copsychus pyrropyga	Orange-tailed Shama
C. saularis	Magpie Robin
C. malabaricus	White-rumped Shama
Enicurus leschenaulti	White-crowned Forktail
E. ruficapillus	Chestnut-naped Forktail
Zoothera everetii	Everett's Ground Thrush
Myophoneus glaucinus	Sunda Whistling Thrush
Eupetes macrocerus	Rail Babbler
Pellorneum capistratum	Black-capped Jungle Babbler
Trichastoma pyrrhogenys	Temmick's Jungle Babbler
T. malaccense	Short-tailed Jungle Babbler

T. rostatum	Blyth's Jungle Babbler
T. bicolor	Ferruginous Jungle Babbler
T. sepiarium	Horsfield's Jungle Babbler
Malacopteron magnum	Greater Red-headed Three Babbler
M. cinereum	Lesser Red-headed Tree Babbler
M. magnirostre	Moustached Babbler
M. albogulare	White-throated Babbler
Pomatorhinus montanus	Chestnut-backed Scimitar Babbler
Ptilocichla leucogrammica	Bornean Wren Babbler
Kenopia striata	Striped Wren Babbler
Napothera atrigularis	Black-throated Wren Babbler
N. crassa	Mountain Wren Babbler
N. epilepidota	Small Wren Babbler
Macronus ptilosus	Fluffy-backed Tit Babbler
Stachyris nigriceps	Grey-throated Tree Babbler
S. poliocephala	Grey-headed Tree Babbler
S. nigricollis	Black-necked Tree Babbler
S. leucotis	White-necked Tree Babbler
S. maculata	Red-rumped Tree Babbler
S. erythroptera	Red-winged Tree Babbler
S. rufifrons	Hume's Tree Babbler
Garrulax lugubris	Black Laughing Thrush
G. palliatus	Grey & Brown Laughing Thrush
G. mitratus	Chestnut-capped Laughing Thrush
Pteruthius flaviscapis	Red-winged Shrike Babbler
Alcippe brunneicauda	Brown Quaker Babbler
Minla casteneiceps	Chestnut-headed Minla
Yuhina zantholeuca	White-bellied Yuhina
Gerygone sulphurea	Flyeater
Cetia whiteheadi	Short-tailed Bush Warbler
C. fortipes	Mountain Bush Warbler
Phylloscopus borealis	Arctic Leaf Warbler
P. trivirgatus	Mountain Leaf Warbler
Seicercus montis	Yellow-breasted Flycatcher Warbler
Abroscopus superciliaris	White-throated Flycatcher Warbler
Orthotomus cuculatus	Mountain Tailorbird
O. ruficeps	Ashy (Red-headed) Tailorbird
Rhipidura albicollis	White-throat Fantail F.
R. perlata	Spotted Fantail Flycatcher
R. javanica	Pied Fantail Flycathcer
Culicicapa ceylonensis	Grey-headed Flycathcer
Muscicapa sibirica	Sooty Flycatcher
M. latirostris	Brown Flycatcher
M. indigo	Indigo Flycatcher
Cyanoptila cyanomelana	Blue and White Flycatcher
Cyornis concreta	White-tailed Blue Flycatcher
C. unicolor	Pale Blue Flycatcher
C. turcosa	Malaysian Blue Flycatcher
C. caerulata	Large-billed Blue Flycatcher
C. banyumas	Hill Blue Flycatcher
C. superba	Bornean Blue Flycatcher
Ficedula hyperythra	White-fronted Blue Flycatcher

F. dumetoria	Orange-breasted Flycatcher
F. westermanni	Little Pied Flycatcher
Muscicapella hodgsoni	Pigmy Blue Flycatcher
Rhinomyias umbratilis	White-throated Jungle F.
R. ruficauda	Rufous-tailed Jungle Flycatcher
R. gularis	White-browed Jungle Flycatcher
Philentoma pyrhoterum	Chestnut-winged Monarch F.
P. velatum	Maroon-breasted Monarch F.
Hypothymis azurea	Black-naped Blue Monarch Flycatcher
Terpsiphone paradisi	Paradise Flycatcher
Pachycephala hypoxantha	Bornean Mountan Whistler
Sitta frontalis	elvet-fronted Nuthatch
Prionochilus thoracicus	Scarlet-breasted Flowerpecker
P. xanthopygius	Yellow-rumped Flowerpecker
P. maculatus	Yellow-throated Flowerpecker
Dicaeum chrysorrheum	Yellow-vented Flowerpecker
D. monticola	Black-sided Flowerpecker
Anthreptes simplex	Pain-coloured Sunbird
A. rhodolaema	Rufous-throat Sunbird
A. singalensis	Ruby-cheeked Sunbird
Hypogramma hypogrammicum	Purple-naped Sunbird
Aethopyga siparaja	Yellow-backed Sunbird
A. mystacalis	Scarlet Sunbird
Arachnothera longirostra	Little Spiderhunter
A. robusta	Long-billed Spiderhunter
A. affinis	Grey-breasted Spiderhunter
A. juliae	Whitehead's Spiderhunter
Zosterops atricapilla	Black-capped White-eye
Chlorocharis emiliae	Mountain Blackeye
Gracula religiosa	Grackle or Talking Myna
Erythrura hyperythra	Bamboo Munia
Dicrurus annectans	Crow-billed Drongo
D. leucophaeus	Grey Drongo
D. hottentottus	Hair-crested Drongo
D. paradiseus	Large Racket-tailed Drongo
Oriolus xanthonotus	Black-headed Oriole
O. cruentus	Black and Crimson Oriole
Platylophus galericulatus	Crested Jay
Dendrocitta occipitalis	Malaysian Treepie
Crovus enca	Slender-billed Crown

263 species

APPENDIX 6: REPTILES RECORDED IN THE GUNUNG MULU NATIONAL PARK.

Reptiles recorded within the Gunung Mulu National Park.
Compiled by J.C. Dring and B.H. Kiew, 1982. Additions after D.W.Gill, 1999.

LIZARDS

GEKKONIDAE, the geckos

Aeluroscalabotes felinus
Cyrtodactylus baluensis
C. malayanus
C. pubisulcus
Cyrtodactylus sp.
Gekko monarchus
C. Cavernicolus
C. smithii

AGAMIDAE, the agamid lizards

Calotes cristatellus
Draco cornutus
D. maximus
D. melanopogon
D. quinquefasciatus
Goniocephalus grandis
G. liogaster
G. miotympanum
Phoxophyrs borneensis
P. nigrilabris
P. spiniceps
Hemidactylus frenatos

SCINCIDAE, the skinks

Mabuya rudis
Norbea beccari
N. brookei
Sphenomorophus cf. Alfredi
Sphenomorphus cyanolaemus
S. multisquamatus
Varanus sp.

55 species

SNAKES

BOIDAE, the pythons

Python reticulatus

COLUBRIDAE, the colubrid snakes

Ahaetulla prasinus
Amphiesma saravacensis
Boiga drapiezii
B. jaspidae
Calamaria borneensis
C. melanota
Dryocalamus tristrigatus
Dryophiops rubescens

COLUBRIDAE (Continued)

Elaphe flavolineata
E. taeniura
Lycodon subcinctus
Macropophis maculata
Pareas malaccanus
Psammodynastes pulverulentus
Rhabdophis chrysargus
R. murudensis
Zaocys carinatus
Z. fuscus

ELAPIDAE, the coral and snakes and cobras.
Bungarus flaviceps
Maticora intestinalis
Naja naja or Ophiophagus hannah

VIPERIDAE, the vipers
Trimeresurus puniceus
T. sumatranus
T. wagleri

TESTUDINES, the tortoises and turtles.

TRIONYCHIDAE, the fresh water turtles.

Dogania sublana. (not positively identified)

EMYDIDAE, the terrestrial or aquatic tortoises.

Cuora amboinensis.
Heosemys spinosa.

APPENDIX 7: AMPHIBIANS RECORDED IN THE GUNUNG MULU NATIONAL PAARK.

Frogs recorded within Gunung Mulu National Park
Compiled by J.C. Dring and B.H. Kiew

BUFONIDAE, typical toads

Ansonia hanitschi
A. longidigita
A. platysoma
Ansonia spp. (possibly 2)
Bufo asper
B. biporcatus
B. divergens
B. juxtasper
Pedostibes hosei
Pelopryne guentheri

MICROHYLIDAE, burrowing frogs

Caluella sp.
Chaperina fusca
Kalophrynus spp. (possibly 2)
Kaloula baleata
Metaphrynella sunda
Microhyla berdmorei
M. borneensis
Microhyla sp.

PELOBATIDAE, spade-foot toads

Leptobrachium gracillis
L. hasselti
L. montanum
Leptobrachium sp.
Megophrys monticola
Nasuta
Megophrys ? sp. Nov.
Nesobia spp. (possibly 4)

RANIDAE, typical frogs

Amolops cavitympanum
A. jerboa
A. kinabaluensis
Ooeidozyga baluensis
O. laevis
Rana blythi
R. ibanorum

RANIDAE (Continued)

R. ingeri
R. malesiana
R. macrodon
R. microdisca
R. Palavanensis
R. baramica
Rana chalonotaR. Glandulosa
R. hosei
R. luctuosa
R. signata
R. laticeps
R. kuhli
Staurois latopalmatus
S. natator
S. tuberilinguis

RHACOPHORIDAE, tree frogs

Edwardtaylori picta
Philautus hosei
Philautus spp. (possibly 8)
Polypedates colletti
P. macrotis
P. otilophus
Rhacophorus appendiculatus
R. baluensis
R. bimaculata
R. dulitensis
R. everetti
R. macroscelis
R. fasciatus
R. nigropalmatus
R. robinsoni
R. pardalis
Rhacophorus sp.

64 (76) species

APPENDIX 8: FISH RECORDED IN THE GUNUNG MULU NATIONAL PARK.

A preliminary list of fish recorded within Gunung Mulu National Park, Compiled by Joan Cramphron.

BAGRIDAE

Mystus baramensis

COBITIDAE

Acanthopthalmus sp.
Noemacheilus fasciatus

CYPRINDAE

Barbus binotatus
B. bramoides
B. bulu
B. collingwoodi
B. douronensis
B. tambroides
Cyclocheilichthys apogon
C. repasson
Garra borneensis
Hampala bimaculata
Labeo pleurotaenia
Leptobarbus hosii
Lobocheilus bo
Luciosoma setigerum
Nematabramis everetti borneensis
Osteochilus hasselti
O. kahajanensis
O. microcephalus
O. vittatus
Oxygaster anomalura
Paracrossocheilus acerus
Rasbora argyrotaenia
R. dusonensis
R. sumatranus
R. volzi

GOBIIDAE

Unidentified species

HEMIRHAMPHIDAE

Hemirhamphodon pogonognathus

HOMALOPTERIDAE

Gastromyzon borneensis
G. nieuwenhuisi
Gastromyzon sp. Nov.
Homaloptera orthogoniata
H. wassinki
H. webberi
Homaloptera sp.
Parahomaloptera microstoma

MASTACEMBELIDAE

Mastacembelus armatus
M. maculatus
M. unicolor

OPHICEPHALIDAE

Ophicephalus striatus

OSPHRONEMIDAE

Osphronemus goramy

SCHILBEIDAZ

Pangasius dezqanii

SILURIDAE

Kryptopterus sp.
Silurus furnessi

SISORIDAE
Glyptothorax major

SYNGNATHIDAE

Dorichthys deokhatoides

48 species

APPENDIX 9 : THE BUTTERFLIES.

Butterflies recorded within Gunung Mulu National Park
Compiled by J.D. Holloway, July 1979

PAPILIONIDAE

Trogonoptera brookiana
Troides amphrysus
Atrophaneura nox
A. neptunus
Pachliopta aristolochiae
Chilasa paradoxa
C. slateri
Papilio demolion
P. nephelus
P. helenus
P. fuscus
P. memnon
P. karna
Graphium sarpedon
G. evemon
G. bathycles
G. doson
G. eurypylus
G. agamemnon
G. empedovana
Pathysa antiphates
P. agetes
P. stratiotes
Paranticopsis delesserti
P. macareus
P. ramaceus
Meandrusa payeni
Lamproptera curius
L. meges

PIERIDAE

Delias ninus
D. georgina
D. henningia
D. eumolpe
D. hyparete
Leptosia nina
Prioneris cornelia
P. philonome
Cepora iudith
C. pactolicus
Appias lyncida
A. nero
A. paulina
Saletara liberia
Ixias pyrene
Hebomoia glaucippe
Pareronia valeria
Dercas verhuelli
Catopsilia pyranthe
C. pomona
Eurema blanda
E. simulatrix
E. ada
E. hecabe
E. sari
E. andersonii
E. lacteola
E. tilaha
E. tominia
Gandaca harina

DANAIDAE

Parantica crowleyi
P. aspasia
P. agleoides
Radena vulgaris
Ideopsis gaura

Idea hypermnestra
I. Iasonia
Euploea camaralzeman
E. Crameri
E. eyndhovii
E algae
E. mulciber
E. modesta
E. leucostictos
E. diocletianus

SATYRIDAE

Melanitis leda
Elymnias kuenstleri
E. penanga
E. esaca
Lethe perimede
Ptychandra talboti

A. indra
A. cardena

Neorina lowii

The order of species follows Corbet & Pendlebury (1978) ed. 3 by J.N. Eliot, Malayan Nature Soc., Kuala Lumpur.

SATYRIDAE (Continued)

Mycalesis anapita
M. orseis
M. maianeas
Orsotriaena medus
Erites argentina
Coelites euptychioides
Ragadia makuta
Ypthima pandocus
Y. baldus
Y. fasciata
Ypthima nov. sp.

AMATHUSIINAE

Faunis canens
F. kirata
F. gracilis
F. stomphax
Taenaris horsfieldii
Xanthotaenia busiris
Amathusia sp.
Thaumantis odana
T. klugius
Discophora necho

NYMPHALIDAE

Ariadne isaeus
Laringa castelnaui
Cupha erymanthis
Phalanta alcippe
Vagrans egista
Vindula erota
V. dejone
Cirrochroa emalea
C. malaya
C. tyche
C. satellita
Terinos clarissa
Cethosia hypsea
Precis atlites
Kaniska canace
Symbrenthia anna
Rhinopalpa polynice
Hypolimnas anomala
Lasippa montana
L. heliodore
Pantoporia aurelia
P. paraka
P. hordonia
Athyma larymna
A. pravara
A. reta
A. abiasa
A. nefte
A. gynea
Pandita sinope
Moduza procris
Lebadea martha
Parthenos sylvia
Tanaecia pelea
T. munda
T. aruna
T. amisa
T. iapis
T. godartii
Euthalia monina
E. whiteheadi
Bassarona dunya
Lexias dirtea
L. canescens
Amnosia decora
Dichorragia nesimachus
Eulaceura osteria
Euripus nyctelius
Prothoe franck
Agatasa calydonia
Polyura athamas
P. jalysus
P. moori
P. delphis
P. schreiber
Charaxes bernardus
C. borneensis
C. solon

RIODINIDAE

Dodona elvira
Abisara savitri

Doleschallia bisaltide
Kallima paralekta
Cyrestis nivea
C. theresae
Chersonesia peraka
C. intermedia
C. rahria
D risa
Neptis duryyodana
N. nata
N. leucopporos
N. hylas

LYCAENIDAE (Continued)

Allotinus macassariensis
A. strigatus
A. substrigosa
Logania regina
Discolampa ethion
Caleta alna
Lycaenopsis haraldus
Celastrina puspa
C. cossaea
C. dilecta
C. musina
C. limbata
C. selma
C. camenae
C. shelfordii
Celastrina sp. Near lingga
Neopithecops zalmora
Catachrysops panormus
Jamides pura
J. zebra
J. elpis
J. cunilda
J. abdul
J. talinga
J. limes
J. cyta
J. lugine
J. alecto
J. bochus
Nacaduba kurava
N. beroe
Ionolyce helicon
Prosotas aluta
P. nora
P. pia
Una usta
Anthene lycaenina
A. emolus

A. geza
A. kausambi

Paralaxita orphna
Laxita teneta

LYCAENIDAE

Miletus heracleion
M. zinckenii
M. gopara
M. gaetulus

Drupadia ravindra
D. theda
D. cineas
Dacalana lowii
Britomartis nov. sp.
Neocheritra amrita
Remelana jangala
Hypolycaena erylus
Zeltus amasa
Rapala manea
Curetis tagalica

HESPERIIDAE

Bibasis harisa
B. etelka
B. sena
Hasora quadripunctata
H. vitta
H. schoenherr
H. borneensis
H. mus
Badamia exclamationis
Charmion ficulnea
C. ladena
Tagiades lavata
T. watersradti
T. ultra
Odontoptilum pygela
Halpe sikkima
Iambrix obliquans
I. Stellifer
Koruthaialos rubecula
K. focula
Psolos fuligo
Ancistroides nigrita

Austrozephyrus borneanus
Arhopala aedias
A. epimuta
A. kinabala
A. catori
A. muta
A. antimuta
A. agesilaus
A. democritus
A. aroa
A. azinis
A. denta
A. paraganesa
A. ariel
Surendra florimel
Amblypodia narada
Eooxylides tharis
Cheritra freja
A. armatus
A. gemmifer
Notocrypta paralysos
Erionota thrax
Unkana ambasa
U. mytheca
Oriens gola
Pelopidas conjuncta

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281 species

APPENDIX 10 : THE CAVE FAUNA.

THE INVERTEBRATE CAVE FAUNA

Dr Philip Chapman. 1984

PLATYHELMINTHES
TURBELLARIA Macrostomida : Temnocephalida

Temnocephalidae
Genus and species undetermined. (status unknown)
These were commonly taken attached to the carapace of crabs such as Sundathelphusa tenebrosa
Holthuis. They probably live as commensals or facultative parasites.

Tricladida (M. Kawakatsu, Sapporo, det.; see Kawakatsu & Chapman, 1983).
Planariidae
Mitchellia sarawakana Kawakatsu & Chapman TB
One small population occurs in shallow pools in "Water Polo Cave".

ANNELIDA (all Annelida sent to E. Easton, British Museum (Natural History)
HIRUDINEA : Gnathobdellida
Genera and species so far not determined.? TB
Pink leeches appear to parasitize roosting bats or swiftlets in Lubang Sungai Payau.

OLIGOCHAETA :
Not systematically collected, a few specimens sent to Easton.

MOLLUSCA
GASTROPODA : Neogastropoda (A. Solem, Chicago det.).
Buccinidae
Clea sp TP
A freshwater whelk, common in Gua Payau, Lubang Sungai Payau and Gua Air Jernih.

GASTROPODA : Stylommatophora
Subulinidae
Lamellaxis clavulinus (Potiez and Michaud) TP
A guanobious snail known from other parts of Borneo and Gua Payau.

ARTHROPODA
CRUSTACEA Isopoda : Oniscoidea. (G A Schultz, Hampton, New Jersey, det;, see Schultz, 1982).

Philosciidae
Setaphora parvicaputa Schultz TP
An amphibious species with a range of pigmentation from olive to white, common in Gua Air
Jernih and also found in several caves near Bau, Southern Sarawak. Other spp. Of this genus are found generally in South-east Asia.

Periscyphidae or Eubelidae
Paraperiscyphis platyperaeon Schultz TB/TP
A large variable species ranging from large-eyed grey, to small-eyed, white

individuals. The latter predominate in deep cave habitats in Gua Air Jernih, Lubang Ular, Gua Ajaib, Lubang Angin and Lubang Darurat Related forms are known from Asia and Africa.

Trachelipidae

Nagarus lavis Schultz TP

A grey, damp-guano-associated species, found in Gua Payau Nagarus is a successful tropical genus, e.g. N. cristatus (Dollfus) is a world-wide tropical expansive species.

Armadillidae

Triadillo annandalei (Collinge) TP

A pretty species patterned in orange, grey and cream. Common on damp guano in Gua Payau but known from outside caves.

Tuberillo sarawakensis Schultz TP

A small orange species covered in blunt spines and tubercles. On damp guano in Gua Payau and Lubang Sungai Payau. This is a genus and species so far unique to the Mulu caves.

Armadillo solumcolus Schultz TB/TP

A small white, eyeless species locally common in Gua Air Jernih on damp mud and arthropod droppings on flowstone.

Gen. indet., sp. nov. TP

A small, spiny, white species with a broad median transverse grey stripe, found on steep walls in the deep threshold of Lubang Angin and "Water Polo Cave".

Gen. indet., sp. nov. ?TP

A small, smooth armadillid with large ocelli found on guano in "Water Polo Cave".

CRUSTACEA Isopoda : Asellota (G. Magniez, Dijon det.).

Asellidae

Stenasellus sp. nov. TB

An eyeless pink species of a genus previously recorded from Western Europe to as far east as Cambodia, and present in small, drip-fed pools in Lubang Ular and "Water Polo Cave" and in a cave near Bau, Southern Sarawak.

CRUSTACEA Isopoda : Anthuridea (S. Andreev, Sofia det.)

Anthuridae

Cyathura sp. nov. TB

An eyeless, white species of genus with a scattered pantropical distribution with cavernicolous species in New Guinea and the Antilles. Occurs in drip-fed pools in Gua Air Jernih (Porcupine Passage) and "Water Polo Cave".

CRUSTACEA Amphipoda (J.H. Stock, Amsterdam det.; see Stock, 1983).

Bogidiellidae (Medigidiella) sarawacensis Stock TB

An eyeless, white species within a sub-genus of otherwise circum-Mediterranean distribution! Found in small, eutrophic pools in Gua Payan and "Water Polo Cave" and in Niah Great Cave, Gunung Subis area, Sarawak.

CRUSTACEA Decapoda : Macrura (L.B. Holthuis, Amsterdam det., see Holthuis, 1979).

Palaemon (Macrobranchium) clymeme (De Man) TP

A freshwater prawn with a range apparently restricted to the upper Baram River catchment. Found in Gua Payau and Lubang Ular.

P. (M.) sp. nov. near clymene ? TB
A few specimens of this depigmented, but eyed, form were taken in the isolated, shallow sumps of Wells series in Gua Air Jernih.

P. (M.) pilimanus (De Man) TP
A species known widely from Borneo, Sumatra and Java, both in epigean and cave localities. Found in Gua Payau and Gua Air Jernih streams.

CRUSTACEA Decapoda: Brachyura (L.B. Holthuis, Amsterdam det.; see Holthuis, 1979).
Potamidae
Cerberusa caeca Holthuis TB
This is the first troglobitic crab known from outside the Americas and is found in Gua Payau, Lubang Hijau, Gua Air Jernih and Lubang Darurat.

C. tipula Holthuis TP
A handsome blue-grey crab with long yellow legs, this species is more amphibious than caeca, and is found in Gua Air Jernih and Lubang Angin.

Sundathelphusidae
Sundathelphusa tenebrosa Holthuis TP
A powerful, riverine crab found in Gua Payau, Lubang Sungai Payau, Gua Air Jernih and "Water Polo Cave".

Gecarcinucidae
Thelphusula prob. Kadamiana (Borradaile) AC
A small crab originally described from the Mt. Kinabalu area (Sabah), and taken in Lubang Kelaiq. Probably an alluvial plain dweller, its main interest is that this is the only record from Gunung Mulu Park.

DIPLOPODA Limacomorpha (R.L. Hoffman, Radford, Virginia det.).
Glomeridesmidae
Genus et sp. nov. TB
A small, white, slug-like millipede found on damp mud in Gua Harimau Bintang and Lubang Darurat. Glomeridesmids are pre-Pangaean forms occuring in the Indoaustralian and Neotropical regions, but not previously recorded from Borneo (R.L. Hoffman, pers. comm.).

DIPLOPODA Oniscomorpha
Glomeridae
Hyleoglomeris sp. nov. TB
A small, white, eyeless pill millipede within a group distributed from East Indies to Palaeartica (R.L. Hoffman, pers. comm.). It is found in considerable numbers in two places in Gua Air Jernih.

DIPLOPODA Polydesmoidea
Pyrgodesmidae
Genus et sp. nov ? TB
Isolated specimens taken in Gua Payau, Lubang Ular and Gua Air Jernih. Hoffman (pers. comm.) comments "pyrgodesmids are pantropical, but so poorly known that I have no idea about their biogeography".

? "Trichopolydesmidae"
? Genus et sp. nov. ? TB
A small, white species with recurved points to back-plates associated with bog-guano patches in Inflation Passage, Gua Air Jernih.

Doratodesmidae

? Genus et sp. nov. ? TB

A small, white species taken in Lubang Ular. This is the first doratodesmid known from Borneo and is a relict of an ancient Sundaland fauna, with relatives in Sumatra, Java, Malaya and Indochina.

New family, or new subfamily of Cryptodesmidae.

Genus et sp. nov. ? TB

A bizarre species with broad, "winged" back-plates known from a single male from Gua Teluk Cahaya Bulan yang Biru, (G. Benarat). Hoffman comments "there is really nothing known to campare it with".

DIPLOPODA Juliformia

Cambalopsidae

Genus et. sp. nov. close to Plusioglyphiulus TB

A white, eyeles, bog guano-associated species related to Plusioglyphiulus cavernicolus known from caves in Bau, Southern Sarawak, and related genera known from Kuala Lumpur and Indochina. This, like the doratodesmid is an ancient Sundaland relict (Hoffman, pers. comm.) It is found in Lubang Sungai Payau, Gua Payau and Lubang Hijau.

CHILOPODA Geophilomorpha (under study by R. Crabill, Washington).

? Geophilidae

Orphnaeus brevilabiatus (Newport) TP

A guanobite found in Gua Payau. When handled it exudes brightly luminous green slime. It is a well-known tropical "vagabond".

CHILOPODA Scolopendromorpha

? Family indet

Genus et sp. indet. ? TB

A large, sandy-brown species with reduced eyes, associated with swiftlet guano in moist habitats. Found in Lubang Sungai Payau, Gua Air Jernih and Gua Ajaib.

CHILOPODA Scutigeromorpha

Scutigeridae

Genus et sp. indet 1. VI

A yellow and brown species wich hunts on cave walls in the threshold of a number of caves and also occurs on the alluvial forest floor.

Genus et sp. indet. 2 TP

A red species found only in the dark zone in Gua Air Jernih and Lubang Ramalan where it hunts on the cave floor.

ARACHNIDA Schizomida, Amblypygi (sent for study to P. Beron, Sofia).

ARACHNIDA Opiliones (sent for study to V. Silhavy, Trebic, Cz.)

According to Silhavy the material was described in 1979 and included "several new genera" (pers. comm.1979) but published references have not been communicated.

ARACHNIDA Scorpionida (under study by M. Vochon, Paris).

Chactidae

Lychas prob. flavimanus Thorell. TP

A slender black scorpion found in "Water Polo Cave", where it feeds on Diestrammena crickets, and commonly on the walls of guano-rich passages in Niah Great (G.Subis) Sarawak.

Chaerilus sp.nov. near gracilis Pocock TB
A pale brown scorpion with long chelae and legs, known only from deep cave habitats in Gua Air Jernih, Lubang Angin and Gua Harimau Bintang.

ARACHNIDA Pseudoscorpionida (studied by the late M. Beier, Vienna).

Neobisiidae
Oratemnus saigonensis (Beier) TP
A deep-burrowing species found in bat guano in Gua Payau.

Ideoroncidae
Pseudocheiridium clavigerum (Thorell) TP
A short-clawed, squat, flattened species which lives just below the surface of bat guano in Gua Payau.

Cheliferidae
Stygiocheflifer cavernae (Tullgren) TB
An eyeless, guano-associated species with extremely long legs and pedipalps found occasionally on guano in Gua Payau. It is also known from Java.

ARACHNIDA Araneae (preliminary identificationby F. Wanless and P. Hillyard, London).

Theraphosidae
Selenocosmia sp. TP?
Gua Air Jernih

Heteropodidae
? TP
Two small, brown, olive and cream-patterned spiders found in Lubang Angin, Lubang Lang and Lubang Darurat. Both species may be common and widespread but were under-collected as, apart from adult males, they strongly resemble immatures of :

Heteropoda sp. nov. near venatoria TP
Found in virtually all caves in the Park, this is a formidable species with an adult leg-span of 15 cm. H. venatoria is a tropicopolitan species thought to have originated in South-east Asia (Wanless, pers. comm.), a supposition supported by the presence of this related troglophile in Mulu and similar (?identical) species in caves near Bau and Niah.

Barychelidae
Idiommata sp. TP
Genus et sp. indet. TP
Two species of trapdoor spiders found in the centre of Gua Air Jernih associated with swiftlet guano.

Scytodiidae
Scytodes spp. 1 & 2 TP
Two species of spitting spiders associated with guano in Gua Payau.

Araneidae
Araneus sp. TP
Common on walls of stream passages near entrances of Goldwater Series in "Gua Air Jernih".

Theridiidae
?Theridon sp. TP
Common in small pockets and abandoned entrances of cricket burrows on mud banks in "Water Polo Cave".

Psechridae
Psechrus mulu Levi TP
Common among boulders in entrances of Gua Payau and Lubang Sungai Payau.

Amaurobiidae
Titanoeca fulmeki Reimoser. TP
Abundant in twilight zone of Gua Payau and Lubang Hijau. Previously known only from Sumatra.

Hersiliidae
Hersilia sp. TP
These "tailed spiders" are abundant on damp walls in the threshold of Gua Payau, Lubang Hijau and Gua Air Jernih).

Pholcidae (under study by P.M. Brignoli, Rome)
Pholcus sp.
A colony exists in the threshold of Gua Payau and occasional specimens were recorded from Lubang Hijau and "Water Polo Cave".
A long-bodied species.

"Spermophora sp. indet. similar to misera Bristowe. TP
A pink, round-bodied species found in transition zone habitats, and associated with swiftlet guano in Gua Air Jernih.

?Genus et sp. nov. 1 ?TB
Similar to Spermophora. The female scape almost reaches the spinnerets, the body is white and the eyes reduced. Found in deep cave habitats near guano, Gua Air Jernih.

?Genus et sp. nov. 2, 3 (?etc.) ?TP/TB
Guano-associated species from Gua Payau, Lubang Hijau, Lubang Angin and Lubang Ular dan Pangga.

?Tetrablemmidae (sent for study to P.M. Brignoli).
Paculla spp. 1 & 2. TP
Two heavily armoured species, one from Lubang Sungai Payau and "Water Polo Cave", the other from Lubang Rendah Harimau (Gunung Benarat).

Genus et sp. nov. TB
A cream-coloured species with two tiny, colourless eyes. The long front legs are used as tactile organs, extended ahead of the body in slow locomotion. Found in deep cave habitats in Lubang Ulr, Gua Air Jernih, Lubang Ramalan dan Lubang Darurat. If not this family possible Ctenidae.

?Ochyroceratidae (sent for study to P.M. Brignoli)
Genus et sp. nov. 1 TB
A tiny, long-legged, eyeless white spider which spins a small sheet web near guano in sheltered situations. The male has an extraodinary forward-projecting head "turret" bearing two sets of down-curving spines. Locally common in Gua Air Jernih.

Genus et sp. nov. 2 TB

A similar species with long ventral setae found in Lubang Ular in damp flowstone pockets.

ARACHNIDA Acari

Uropodidae (B.D. Ainscough, Victoria, B.C., Canada det.)
? TP
Hemispherical, hard-backed, orange-brown mites present in extremely high densities in bat guano in Gua Payau.
Urosternella sp. TP
Fuscuropoda sp. TP
Leiodinychus sp. TP

Arranged in decreasing order of size, these three guano scavengers are present in large numbers in bat guano in Gua Payau.

Macrochelidae (G.W. Krantz, Oregon det.)
Macrocheles sp. nov. TP
Members of this genus generally feed on nematodes or eggs and early larval instars of Diptera.
This species may be phoretic on guanobious flies or beetles. Found on guano in Gua Payau.

Laelapidae (G.W.Krantz, Oregon det.)
Hypoaspis ? sp. nov. TP
This genus is associated with animal nests; many are phoretic on insects and all are predaceous.
Found on bat guano in Gua Payau.

Family indet.
Genus sp indet. TP
Mites associated with swiftlet droppings in humid habitats in Gua Air Jernih.

INSECTA Diplura (B. Conde, Nancy det.).

Campodeidae
Lepidocampa weberi ? subsp. nov. TP
Probably a soil-dweller, found in Lubang Ular on muddy flowstone.

INSECTA Collembola (P.N. Lawrence, London det.).

Paronellidae : Troglopedetinae
?Genus et sp. nov. 1, 2. ?TB/TP
Tropical troglopedetines are poorly known. These species have 3+3 eyes instead of the more usual 8+8 and are found on swiftlet droppings in damp habitats in Gua Air Jernih.

Cyphoderidae
Genus et sp indet TP
This species is associated with the ant Gnamptogenys menadensis on wet guano and beneath the surface of dry guano in Gua Payau.

INSECTA Thysanura (J.Paclt, Ivanka, Cz. det.).

Nicoletiidae
Genus et sp. nov. TP
Found beneath rocks in the splash zone of the Lubang Sungai Payau stream.

Meinertellidae
Machilontus sutteri borneensis Paclt TP
Found on walls of passages in the transition zone of Goldwater series, Gua Air Jernih.

INSECTA Dictyoptera : Blattaria (L. Roth, Natick, Mass. det.; see Roth, 1980).
Blattellidae : Blattellinae

Trogloblattella chapmani Roth TB

A small-eyed, orange coloured species characteristec of the SCAT association (see Chapman, 1982) and confined to deep cave microhabitats.. Found in most caves, away from guano beds. The only other *Trogloblattella* is a troglobite from South and Western Australia.

Blattella (formerly Symploce) cavernicola (Shelford) TP
A fast-running guano scavenger which congregates in enormous number on boulders in Gua Payau. It is also found in Sumatra, Malacca and Thailand and in caves near Bau, Southern Sarawak (the type locality).

Blaberidae : Pycnoscelinae

Pycnoscelus indicus (Fabricius) TP

A burrowing guano-scavenger found in large numbers in Gua Payau. This species is often confused with P. surinamensis, so that its range is not precisely known (Roth, 1980).

INSECTA Orthoptera (T. Hubbell, Michigan det.)

Rhaphidophoridae

Diestrammena mjobergo Chopard TP

A medium-sized, light brown cricket associated with swiftlet guano or scattered faeces throughout most caves in the Part. Favours a stalbe, high atmospheris humidity.

Diestrammena sarawakana Chopard TP

A smaller, more delicate species with contrastingly banded body and legs, associated with guano wherever mjobergi is absent, usually close to entrances. It seems to favour bat guano, but is excluded from very rich guano habitats by guanobious Blattaria.

Rhaphidophora oophaga Chopard. TP

A very large, robust, grey-brown cricket with finely striped hind femora. It occurs widely in almost every cave in the Park. Adults predate swiftlet eggs and young chicks (Chopard, 1959) and all instars burrow in the extensive "cricket mud" deposits present in most caves.

Genus et sp. indet. TX

A species intermediate in size and appearance between D. sarawakana and R. oophaga and found in Lubang Kelaiq in sheltered roof pockets during the day. It emerges to feed outside the cave at night.

INSECTA Dermaptera (A. Brindle, Manchester det.; see Brindle 1980)

Labiidae

Irdex chapmani Brindle TP

Found beneath rocks in bog guano in Gua Payau. Other Irdex species are found in Borneo, but I chapmani is closer to some Philippine species.

Labiduridae

Chelisoches brevipeenis Borrelli ?TP

A species originally descibed from the Philippines and similar to C. bimmamatus from the Batu caves, W. Malaysia. It is found on guano in "Water Polo Cave".

Nala ornata Borelli TP

A slender, hygrophilic species found under boulder in the splash zone of the Lubang Sungai Payau stream. It was originally described from the nearby Baram River. Specimens taken in 1978 were wrongly identified by Brindle (1980) as Parapericomus sp.

Arixeniidae

Arixenia esau Jordan AC

A "hairy earwig" found in Gua Payau and generally associated with the naked bat, Cheiromeles torquatus, which, though nor recorded in that cave, has been seen leaving a small cave entrance in the limestone ridge some 300 m above Gua Payau (D. Labang, per. Comm.). As the top of the aven below which Arixenia occurs cannot be seen, it is possible that naked bats occupy an undiscovered upper gallery with a separate entrance, connected to the known portion of Gua Payau by the aven. As the earwig lives on the bat, its presence in caves is accidental.

INSECTA Hemiptera (P.S. Broomfield, London det.)

Reduviidae

Bagauda ?sp. nov near cavernicola Paiva TP

This slender, long-legged assassin bug hunts on the wall in the threshold of Gua Payau. B. cavernicola is known from Assam.

Gerridae

Metrocoris nigrofasciatus Disftant TP

A water striders found on the southern stream in Gua Payau.

Veliidae

Genera et spp. Indet. TP

Asmall water striders found on shallow pools in Gua Air Jernih.

Lygaeodae : Rhyparochrominae

Genera et spp. Indet. TP

A shieldbug which is particularly abundant on patches of "nutty guano" of the fruit bat Balionycteris maculata. Tit is also found in caves near Bau (Southern Sarawak) on identical-looking guano in association with the snail Lamellaxis gracilis Hutton.

Cercopidae

Trichoscarta deianora Breddin TP

A phytophagous homopteran, brightly patterned in orange and black, which sucks the sap of tree roots entering shallow cave passages (Lubang Kelait and Tharg's Series in Gua Air Jernih. It is also found in Posih Cave, near Bau.

INSECTA Trichoptera (P. Barnard, London det.)

Calamoceratidae

Anisocentropus sp.

Hydropsychidae

Hydropsychodes sp.

Macronema sp.

Psychomyiidae

Tinodes sp.

Various genera et spp. Indet

Goeridae

Various genera et spp. indet.

Goeridae

Various genera et spp. indet.

The ecological status of all these species from Gua Payau and Lubang Sungai Payau is not known. Barnard comments (pers. comm.) that "many of the species may well be confined to caves". Most are presently unidentifiable.

INSECTA Lepidoptare (D.S. Robinson, London det.)

Tineidae

Crypsithyrodes concolorella (Walker) TP

Tinea porphyopa Meyrick TP

Both species are common on bat guano in Gua Payau.

C. concolorella is a tropical cosmopolite, while T. porphyropa ia s Sundaland species. Both are found almost exclusively in caves.

Tinea antricola Meyrick TP

This species occurs on swiftlet guano in most Mulu caves and is wisespread in South-eat Asian caves. The larvae of all three tineids build characteristically-shaped cases of fragments of insect cuticle.

INSECTA Coleoptera (P.M Hammond, London det.) (except Leiodidae).

Carabidae

Brachidius crassicornis Chaudoir TP

On guano in "Water Polo" and Gua Payau where it probably preys on small oligochaetes or nemotodes.

Hyphoereon ?sp. nov. TP

A handsome blue beetle with cream legs found on swiftlet guano in Lubang Sungai Payau where it probably feeds on cricket eggs.

Anaulacus sericippennis Macleay TP

An orange and black burrowing species found in swiftlet guano in Lubang Sungai Payau.

Histeridae

Hister sp. TP

Gnathoncus sp. TP

Both are found on guano in Gua Payau where they prey on tineid larvae.

Leiodidae

Ptomaphaginus chapmani Peck ?TB

A small orange-brown beetle with reduced eyes, found in the deep cave of most Mulu caves where it feeds on dead swiftlets and bog guano. According to Peck (1981) P. chapman is descended from an ancestor which was widely distributed across Sundaland during the Tertiary, and is most closely related to P. latescens from Sumatra.

Staphylinidae

Lithocharis vilis Kraatz TP

This beetle is associated with bog guano in Gua Payau and Gua Air Jernih and is not recorded outside caves in Mulu.

Atheta sp. 1 TP

Anotylus sp. 1 TP

Two small scavenger found in Gua Air Jernih and Lubang Kelaiq respectively.

Triogidae

Trox costatus Wied. TP

A sluggish coprophage found in huge numbers on bat guano in Gua Payau.

Tenebrionidae

Tenebrio antricolor Blair

A scavenger common on bat guano in Gua Payau. It prey on Arixenia.

Aderidae

Euglenes troglodytes Champion TP

Eugleness malayanus Werner TP

Euglenes cephalicus Werner TP

The first species is abundant on swiftlet guano in most Mulu caves, the other are fairly rare.

Dermestidae

Attagenus nudulatus Motschulsky TP

Found on bat guano in Gua Payau

Melyridae

Idgia sp. TP

Found on swiftlet guano in Gua Harimau Bintang and "Water Polo Cave:.

Elateridae

Neotrichophorus germanus Elentiaux TP

A guano scavenger found in Gua Air Jernih and Gua Payau.

INSECTA Diptera (N. Wyatt and P. Cranston, London det.) (except ectoparasites).

Identification is not possible beyond family level for most specimens (except ectoparasites), and their ecological dependence on caves is not known, but probably most guano-associated forms are troglophilic, while many species with stream-dwelling larvae are accidental. Below is a list of families associated with guano and flowimg water, with an idea of their relative abundances.

Guano-associated :

Milichiidae (extremely abundant)

Ceratopognidae (common)*

Chironomidae (common)+

Chloropidae (common)

Cecidomyidae (uncommon)

Mycetophilidae (uncommon)

Sciaridae (uncommon)

Phoridae (uncommon)

Sphaeroceridae (uncommon)

Unknown family (?Brachycara) (uncommon)

Tachinidae (uncommon)

Culicidae (uncommon)*+

Drosophilidae (rare)

Tethinidae (rare)

Muscidae(rare)

Tipulidae(rare)

Dolichopdidae(rare)

Families marked * are blood-sucking flies which may attack bats or swiftlets. Families marked + have aquatic larvae found in guano-rich pools.

Stream-associated

Chironomidae (very abundant)

Tipulidae (rare)

Chaoboridae (rare)

Ectopparasites (A.M. Hutson, London det.).

Nyctetibiidae

Nyctetibia allotopoides

Nyctetibia parvuloides

Taken on a bat, Miniopterus ? australis, in Gua Air Jernih.

INSECTA Hymenoptera (B. Bolton, London det.).

Formicidae

Pachycondyla tridentata (Smith) TP

A large black stinging ant with a red-tipped abdomen found on guano in Gua Payau and Lubang Angin and also in Niah Great Cave.

Crematogaster sp. TP

Found in Gua Payau on wet guano and in Lubang Kelaiq.

Gnamptogenys menadensis Smith TP

A small yellow ant common on wet guano in Gua Payau and associated with a cyphoderid springtail.

Pheidologeton silenus Smith TX

Monomorium sp. TX

Two small yellow ant found in Lubang Kelaiq.

?Pheidole longipes (Smith) TX

A long-legged ant found near the Skylight in Snake Track passage, Gua Air Jernih

Pheidole sp. TP

Associated with swiftlet guano in Gua Air Jernih and Lubang Darurat.

Chalcididae

Stenogaster sp. TX

Colonies of this potter wasp nest on the ceiling of Lubang Kelaiq close to two entrances.

Ichneumonidae and Braconidae

A number of species (7+) were taken on guano in Gua Payau, Lubang Sungai Payau and Gua Air Jernih but are not studied by the British Museum (Natural History).

APPENDIX 11 : GUNUNG MULU NATIONAL PARK PROCLAMATION (1974)

SARAWAK GOVERNMENT GAZETTE

2350 3rd October, 1974

No. 2852

THE NATIONAL PARKS ORDINANCE

THE GUNUNG MULU NATIONAL PARK PROCLAMATION

(Made under section 7(2))

1 This Proclamation may be cited as the Gunung Mulu National Park Proclamation, 1974.

2 The land described in the Schedule shall with effect from 1st August, 1974 be constituted a National Park, to be known as the Gunong Mulu National Park.

3 The privileges conceded within the National Park shall, subject to the provision of section 14 of the National Parks Ordinance, be as follows:

(a) The inhabitants of the following longhouses under the jurisdiction of Penghulu Baya Malang :

Kuala Tutoh (Long Kiput)
Batu Belah
Long Panai
Long Terawan
Long Melinau
Sungei Iman
Sungei Abang
Sungei Ubong
Sungei Tapin

shall have the privilege of hunting pig (Sus spp.) and deer (Tragulus spp. Muntiacus spp. and Cervus spp.) within the drainages of the Sungei Melinau Paku, Sungei Lansat, Sungei Tapin and other small rivers draining into the Sungei Tutoh between Long Tapin and Long Melinau.

(b) The inhabitants of the longhouses mentioned in paragraph (a) above shall have theprivilege of taking fish from the Sungei Melinau Paku, Sungei Lansat, SungeiTapin and other small rivers draining into the Sungei Tutoh between Long Tapin and Long Melinau and all tributaries of these rivers.

(c) The inhabitants of the longhouses mentioned in paragraph (a) above shall have the privilege of collecting from the areas mentioned in paragraph (a) the following forest produce :

(i) damar,

(ii) rotan,

(iii)getah, including gelutong, getah rian, and malau,

(iv)pandan leaves, ahd leaves of other plants, for basket making and weaving,

(v) edible plants or parts thereof, including fruits, leaves, roots.

(d) Nomadic Punans living within the Park, shall have the privileges mentioned in paragraphs (a) to (c) above but such privileges shall cover the whole area of the Park. In addition, the Nomadic Punans shall have the privilege of taking timber and poles for firewood and the construction of temporary houses. Nomadic Punans that adopt a settled mode of existence shall forego the privileges included in this paragraph and have the same privileges as the inhabitants of the longhouses mentioned in paragraph(a).

(e) The inhabitants of the longhouse at Long Seridan shall have the privileges mentioned in paragraphs (a) to (c) above but such privileges shall be confined to the drainage of the Sungei Ubong and its tributaries.

(f) The inhabitants of the longhouses under the jurisdiction of Penghulu Madang shall have the privileges of hunting pig (Sus spp.) and deer (Tragulus spp., Muntiacus spp. and Cervus spp.) within the drainage of the Sungei Mentawai, and of taking fish from the Sungei Mentawai and its tributaries.

SCHEDULE

(paragraph 2)

BOUNDARY DESCRIPTION

Name	:	Gunong Mulu National Park
Division	:	Fourth and Fifth
District	:	Baram and Limbang
Area	:	130,630 acres approximately

Boundaries:

Commencing at Nanga Mentawai the boundary follows the true left bank of Sungei Medalam upstream for 1,136 chains to the mouth of a tributary, 530 chains on a bearing 24 00' from the summit of Gunong Mulu; thence along a cut line bearing 180 00' for 60 chains to the Fourth/Fifth Divisional boundary; thence in a South-easterly direction along the Divisional boundary for 95 chains to a ridge; thence in a South south-westerly direction along the watershed of Sungei Seridan and Sungei Melinau for 252 chains to the source of Sungei Ubong; thence downstream along th true right bank of Sungi Ubong for 1,341 chain to its confluence with Sungei Tutoh, thence downstream along the true right bank, thence along series of cut lines bearing 314 00' for 25 chain 260 00' for 6 chain, 314 00'for 4 chains, 215 00' for 1 chain, 314 00' for 51 chains and 1- 00' for 110 chains to a point on the true left bank of Sungei Melinau Paku, thence dowstream along the true left bank of Sungei Melinau Paku for 7 chains to its confluence with Sungei Melinau, thence upstream along the true left bank of Sungei Melinau for 520 chains to the mouth of Sungei Putut, thence upstream along the true left bank of Sungei Putut for 505 chains to its source, thence a cut line bearing 312 00' for 15 chains to the Fourth/Fifth Divisional boundary, thence in a South-westerly direction along the Divisional boundary for 76 chains to the Sarawak/Brunei International boundary; thence in a north-easterly direction along the International boundary for 716 chains to a point on a straight line joining Bukit Ulu Tutong and Nanga Mentawai; thence a cut line bearing 129 00' for 185 chains to Nanga Mentawai, the point of commencement.

N.B. Bearings and distances are approximate only and the demarcated boundaries shall be considered correct.

IGNATIUS L. ANGKING,
Resident, Fourth Division.

APPENDIX 12 : THE NATIONAL PARKS AND NATURE RESERVE ORDINANCE

3.10.1998

ABILL

Intituled

An Ordinance for the constitution and management of National Parks and Nature Reserves and all matters incidental thereto.

Enacted by the Legistature of Sarawak

PART I

PRELIMINARY

Short title and commencement.

1. This Ordinance shall be cited as the National Parks and Nature Reserves Ordinance, 1998, and shall come into force on the 1st day of January, 1999.

Interpretation.

2. Inthis Ordinance -

"animal" means any species of animal, and includes mammals, birds, fish, reptiles, amphibians, insects, invertebrates, or any recognizable part or derivative thereof;

"building" includes any house, hut, shed, or roofed enclosure, whether used for the purpose of human habitation or otherwise, and also any wall, fence, platform, staging, gate, post, pillar, paling, frame, hoarding, slip, dock, wharf, pier, jetty, landing-stage or bridge, or any structure, support or foundation connected to the foregoing;

"Chief Park Warden" means a Chief Park Warden appointed under section 3(2);

"Controller" means the Controller of National Parks and Nature Reserves appointed under section 3(1), and includes a Deputy Controller;

"historical monument" has the meaning assigned to it in the Sarawak Cultural Heritage Ordinance, 1993; Cap.6

"historical site" has the meaning assigned to it in the Sarawak Cultural Heritage Ordinance, 1993; Cap.6

"land" means unalienated State land and any other land held or registered in the name of the Government of Sarawak for the purpose of a national park or nature reserve;

"infrastructure" includes road, railway, dam, power transmission line, cable car, and airfield;

"Minister" means the Minister for the time being charged with the responsibility for national parks and nature reserves;

"national park" means any -
(a) area of land;
(b) inland water area; or
(c) area within the territorial waters of the State,

constituted as a national park under Part III for -

(i) conservation and protection of wild life and their habitat;

(ii) preservation of geological or physiographical features of special interest on land and in areas beneath the territorial waters of the State;

(iii) facilitating study and research on the biodiversity of the State;

(iv) protection of the natural scenic beauty, and the historical sites and historical monuments on land and in the territorial waters of the State;

(v) according opportunities for public appreciation, enjoyment and education of the natural scenic beauty, wild life habitat, flora and fauna, geological and physiographical features, historical sites and historical monuments of the State;

"nature reserve" means any -
(a) area of land;
(b) inland water area; or
(c) area within the territorial waters of the State,

constituted as a nature reserve under Part III for -

(i) the preservation of specific natural features, landscape and site for archeological, recreational, educational or conservation purposes;

(ii) the preservation and protection of any particular historical site or historical monument on account of their unique natural beauty or interest; and

(iii) enhancing public appreciation, interest and education in the features, landscape, historical site or historical monument mentioned in (i) and (ii) above.

"park officer" means any officer appointed under section 3, and includes the Controller;

"plant" means any species of plant, including all flowering and non-flowering species, or any recognizable part or derivative thereof;

"Sarawak Biodiversity Council" means the Sarawak Biodiversity Council established under section 3 of the Sarawak Biodiversity Centre Ordinance, 1997; Cap.24.

"warden" means a park warden appointed under section 3(2);

"weapon" includes any firearms, knives, blowpipes, spears, traps, snares, and any other type of weapon in common use by natives of Sarawak;

"wild life" means any species of wild animal or wild plant which exists, or whose habitat is, in the wild or natural state, in Sarawak or elsewhere in the world.

PART II

ADMINISTRATION OF NATIONAL PARKS AND NATURE RESERVES

Appointment of Controller of National Parks and Nature Reserves.

3. (1) The Minister may appoint a Controller of National Parks and Nature Reserves from among members of the public service of the State for the purpose of performing the functions and duties assigned to him under this Ordinance.

(2) The Minister may appoint a Deputy Controller of National Parks and Nature Reserves and such number of Chief Park Wardens, Park Wardens, Park Rangers and such other officers as may be considered necessary for carrying out the purposes of this Ordinance.

(3) All officers appointed under subsection (2), including a Deputy Controller, shall be subject to the control, direction and supervision of the Controller.

(4) All officers appointed under this Ordinance shall be deemed to be public servants within the meaning of the Penal Code. Act 474.

Functions and duties of the Controller.

4. (1) The Controller shall -

(a) be responsible for the administration and enforcement of this Ordinance;

(b) exercise supervision and control of, and manage, national parks and nature reserves;

(c) institute measures for the protection of national parks and nature reserves and to promote public appreciation and enjoyment thereof;

(d) protect and develop schemes and policies for the protection of wild life and their habitats within national parks and nature reserves which are not inconsistent with the provisions of the Wild Life Protection Ordinance, 1998; Cap. 26.

(e) provide such facilities as may be necessary for the accommodation, enjoyment and comfort of visitors to national park and nature reserve;

(f) demarcate a national park or nature reserve into various zones or areas to facilitate effective and proper management and control thereof;

(g) subject to section 25, engage or appoint any person to manage on his behalf any facilities provided for the purpose stipulated in (e) above or any historical site, historical monument, geological or physiographical features within a national park or nature reserve, and to provide the services referred to in section 25(1)(b);

(h) perform such other duties in relation to this Ordinance as the Minister may from time to time determine; and

(i) carry on such other activities as may appear to the Controller, requisite, advantageous or convenient for the purpose of carrying out the provisions of this Ordinance.

(2) The functions and duties of the Controller shall, subject to the direction of the Controller, be exercisable by the Deputy Controller.

(3) The Minister may give the Controller such directions, not inconsistent with the provisions of this Ordinance, as he thinks fit, as to the exercise and performance of his functions and duties under this Ordinance, and the Controller shall give effect to all such directions.

Delegation of functions or duties by the Controller.

5. The Controller may, in writing, delegate to any officer under his control, direction and supervision the exercise or performance, subject to such conditions, limitations or restrictions as may be provided in the instrument of delegation, of any of his functions or duties assigned to him under this Ordinance:

Provided that any delegation under this section with respect of any function or duty shall not prevent the

Controller from himself exercising or performing such delegated function or duty in any case where is appears expedient to do so.

Functions and duties of Chief Park Warden.

6. (1) A Chief Park Warden shall exercise the functions and duties assigned by the Controller to him in the geographical locality under his jurisdiction.

(2) A Chief Park Warden shall report to the Controller any matter in respect of which any action on the part of the Controller is necessary.

(3) A Chief Park Warden shall be vested with the functions and duties of a Warden or Ranger.

Functions and duties of Chief Park Warden.

7. (1) A Park Warden shall be responsible for the control and management of a national park or nature reserve, and shall report to the Chief Park Warden having jurisdiction over the national park or nature reserve, pertaining to all activities and incidents occurring therein;

(2) A Park Warden shall be assisted in the discharge of his functions and duties by such number of Rangers as may be determined by the Controller.

Special Park Committee.

8. (1) The Controller may constitute a Special Park Committee, which shall be headed by a Warden to assist the Controller in the protection and management of a national park or nature reserve and to promote public appreciation and enjoyment thereof.

(2) A Special Park Committee shall consist of not more than twelve members, and shall comprise park officers, Honorary Wild Life Rangers appointed under section 8 (1) of the Wild Life Protection Ordinance 1998, and any other persons residing near a national park or nature reserve and such other persons who, in the opinion of the Controller, would be able to assist him in the protection and management of a national park or nature reserve.

(3) (a) The Controller may designate any part of a national park for the exercise of subsisting rights or privileges which are recognised under section 11.

(b) In the exercise of his powers under subsection (1), the Controller shall take into account any recommendation which may be made to him by a Special Park Committee pertaining to the exercise of such rights and privileges within the national park.

PART III

ESTABLISHMENT OF NATIONAL PARKS AND NATURE RESERVES

Constitution of a national park or a nature reserve.

9. (1) Subject to the provisions of this Part, a national park or nature reserve may be constituted over -

(a) any area of land, including land within a forest reserve or wild life sanctuary and land within a historical site or historical monument;

(b) any inland water area; or.

(c) any area within the territorial waters of the State.

(2) Where a historical site or historical monument is within a national park or nature reserve, that historical site and historical monument shall be preserved and managed in accordance with the provisions of the Sarawak Cultural Heritage Ordinance, 1993. Cap.6

Procedure for constituting a national park or a nature reserve.

10 (1) Where it is proposed to constitute a national park or nature reserve over State land which is not within a forest reserve or wild life sanctuary, the Minister shall publish in the Gazette a notification -

(a) specifying as accurately as possible the description and limits of the land intended to be constituted as a national park or nature reserve;

(b) directing any person claiming any right or privilege in or over such land to submit, within sixty days from the date of publication of such notification, to the Chief Park Warden for the area in which the land is situated, his claim with evidence in support thereof; and

(2) A copy of the notification shall be published in at least one newspaper circulating in Sarawak, and displayed at the District Office for the area to be constituted a national park or nature reserve or be brought to the notice of the persons affected thereby in such a manner as the Minister thinks necessary.

Rights or privileges.

11. The rights or privileges that may be recognized in an area to be constituted as a national park or nature reserve shall be only those rights or privileges which have been enjoyed or exercised by or accrued to a native or his forefathers or a native community for an uninterrupted period beginning from a date prior to 16th February 1956 to the date of the notification referred to in section 10.

Claim.

12. (1) A claim in respect of any right or privilege in or over the land to be constituted as a national park or nature reserve must be made in writing and in such form as may be prescribed by the Controller.

(2) A claim to such right or privilege may be submitted to the Chief Park Warden by a Headman on behalf of any person claiming such right or privilege.

(3) Any person who fails to submit a claim to any right or privilege in or over the land to be constituted a national park or nature reserve within the period stipulated in the notification, shall be deemed to have abandoned or waived such right or privilege and shall not be entitled to exercise the same after constitution of the national park or nature reserve.

Inquiry into claim.

13. (1) The Chief Park Warden shall, within sixty days from the date of receipt of any claim submitted under section 12, or such extended period as the Controller may allow, conduct an inquiry into such claim.

(2) In any such inquiry, the onus of proving the existence of any right or privilege claimed shall be on the claimant.

(3) The Chief Park Warden may call for and receive any evidence to verify, confirm or support any claim from any claimant or any public officer or any other person having knowledge of such claim. In the conduct of such inquiry, the Chief Park Warden shall have the same powers to summon and examine witnesses as a Magistrate.

(4) Where it is considered necessary and expedient, any inquiry conducted pursuant to this section may be held in public at such time, on such date and at such location as may be specified in a notice to be issued by the Chief Park Warden.

14. (1) The Chief Park Warden shall, upon conclusion of the Inquiry, furnish a report thereof to the Controller.

Report.

(2) The report shall contain the notes of proceedings and evidence recorded at the inquiry together with such findings and recommendations as the Chief Park Warden may deem it fit or proper to make.

Rights or privileges admitted.

15. Where any right or privilege is admitted or found to have subsisted at the time of the notification published under section 10, the Controller shall -

(a) regulate the exercise or enjoyment of such rights or privileges including directing the areas or places within a national park or nature reserve where the rights or privileges may be exercised or enjoyed and the manner of exercising or enjoyment thereof; or

(b) with the approval of the Minister, proceed to extinguish such rights or privileges and pay adequate compensation to the lawful claimant thereof.

Assessment of compensation.

16. In assessing the compensation payable under this Part for the extinguishment of any right or privilege in or over the area constituted or to be constituted a national park or nature reserve, the Controller shall take into account the following -

(a) the nature and extent of the right or privilege claimed;

(b) whether such right or privilege is still exercised or enjoyed by the claimant at the date of notification published under Section 10;

(c) the degree of actual dependency, if any, of the claimant on such right or privilege, as a means of his livelihood;

(d) if the right or privilege relates to the planting of any crop, whether alternative site or area has been provided by the Government for the person or the community to which he belongs, for farming; and

(e) any other relevant factors or circumstances pertaining to the enjoyment or exercise of such right or privilege.

Decision on compensation.

17. The decision of the Controller on the compensation payable to any claimant under this Part shall be served on the claimant at the address provided by him at the time of submission of his claim or if his claim is submitted through his Headman, the decision shall be served on the claimant by handing a copy thereof to the Headman.

Appeal.

18. (1) Any person aggrieved by the decision of the Controller may, within thirty days from the date of service of the decision on him, appeal to a Sessions Court.

(2) An appeal to a Sessions Court shall be by way of originating application and shall follow the procedures prescribed by the Subordinate Courts Rules 1980. P.U.(A) 328/80.

(3) Subject to the Subordinate Courts Rules 1980, a Judge of the Sessions Court may give such direction as he may deem fit or necessary for the disposal or hearing of any appeal before him under this Section.

Notification.

19. (1) At any time after the Controller has made a decision on the compensation for extinguishment of rights or privileges under section 16, the Minister may, with the approval of Majlis Mesyuarat Kerajaan Negeri, publish in the Gazette, a notification to constitute the area specified in the notification referred to in section 10, a national park or nature reserve.

(2) Such notification shall -

(a) state the name of the national park or nature reserve;

(b) specify the limit of the national park or nature reserve;

(c) state the date on which the notification shall take effect;

(d) declare whether all rights or privileges in the national park or nature reserve have been extinguished; and

(e) stipulate the special conditions, if any, governing the reservation thereof.

Constitution of a national park or a nature reserve, within a forest reserve, etc.

20. (1) The Minister, with the approval of Majlis Mesyuarat Kerajaan Negeri may, by notification in the Gazette, constitute any area within a forest reserve, wild life sanctuary or a special area declared under the Parks and Greens Ordinance, 1993, to be a national park or a nature reserve.

(2) The notification under subsection (1) shall -

(a) state the name of the national park or nature reserve;

(b) state the date on which the national park or nature reserve is constituted;

(c) where the national park or nature reserve is constituted within a forest reserve or wild life sanctuary, declare the area on which the national park or nature reserve is constituted, shall cease to be a forest reserve or a wild life sanctuary;

(d) provide a detailed description of the area to be constituted a national park or nature reserve;

(e) limit or prohibit the exercise or enjoyment of any subsisting rights or privileges in the national park or nature reserve.

(3) Any area constituted a national park or nature reserve pursuant to this section shall -

(a) be deemed to have ceased to be part of the forest reserve and the provisions of section 24(2) and (3) of the Forests Ordinance shall apply; or Cap. 126.

(b) be deemed to have ceased to be a wild life sanctuary and the provisions of section 27 of the Wild Life Protection Ordinance, 1998 shall apply; or

(c) be deemed to have ceased to be a special area under the Public Parks and Greens Ordinance, 1993. Cap.3.

(d) be managed, administered and controlled by the Controller, subject to such direction as may be given to him, by the Minister.

Effect of notification.

21. (1) From the date referred to in the notification gazette under section 19 (1) or 20 (1), no person shall -

(a) enter and reside in a national park or nature reserve without the written permission of the Warden in charge thereof;

(b) exercise and enjoy any right or privilege in the national park or nature reserve, whether such right or privilege were awarded under licence, permit, or accrued or recognized under any written law, except in accordance with the written directive or guidelines issued by the Controller; and

(c) undertake any activities, studies or research in the national park or nature reserve without the prior written permission of the Controller, who shall, if such permission is to be given to a person who is not a member of the public service of the State, consult the Chief Executive Officer of the Sarawak Biodiversity Council before granting such permission.

(2) Any person who fails to comply with any of the provisions of subsection (1) may be removed or evicted from the national park or nature reserve by the Warden or a police officer not below the rank of Inspector.

Alienated land.

22. (1) The inclusion of any alienated land in a national park or nature reserve shall be deemed to be a public purpose within the meaning of section 46 of the Land Code. Cap. 81. (1958 Ed.).

(2) Where alienated land has been acquired for the purposes specified in subsection (1), the Minister may include the land so acquired in the Notification made under section 19.

National park and nature reserve be the property of the Gov't of Sarawak.

23. (1) From the date of constitution of a national park or a nature reserve, the place so constituted shall be the property of the Government of Sarawak and shall subject to the provisions of this Ordinance, be managed and controlled by the Controller.

(2) Nothing in this Part shall authorize the Controller to grant any permit or licence to any person who is not a member of the public service of the State to take away, remove any wild life for research purposes without the prior approval of the Chief Executive Officer of the Sarawak Biodiversity Council.

PART IV

MANAGEMENT OF NATIONAL PARKS AND NATURE RESERVES

Minister may give directions to Controller.

24. (1) The Minister may give to the Controller directions of a general character not inconsistent with the provisions of this ordinance as to the exercise and performance of his functions and powers in relation to any matter which appears to him to concern the protection and conservation of national parks and nature reserves in the State.

(2) For the purpose of carrying out the duties and functions imposed upon him by subsection (1), the Controller may within a national park or nature reserve-

(a) construct such trails, interpretive displays, bridges, buildings and fences, provide water supplies and sewage and refuse disposal facilities as he considers necessary;

(b) take such measures as may be necessary for the protection of the wild life, geological and physiographical features in a national park or nature reserve and the preservation of such national park or nature reserve and the wild life therein in their natural state;

(c) reserve or set aside any portions of a national park or nature reserve as breeding places for animals, and as nurseries for plants; (d) provide such accommodation, amenities, facilities and services as are likely to attract visitors to the national park or nature reserve and are not prejudicial to the proper care, control and management thereof.

(3) No infrastructure shall be built within the boundaries of a national park or nature reserve, except with the written permission of the Controller, in consultation with the Minister.

(4) Before any permission is given under subsection (3), the Controller shall be satisfied that -

(a) the construction of such infrastructure in a national park or nature reserve are essential and in the public interests;

(b) there is no alternative route or site for such infrastructure outside the national park or nature reserve;

(c) an environmental impact assessment of such infrastructure in a national park or a nature reserve has been undertaken and that all conditions and measures to mitigate against any adverse environmental impact have been complied with, or implemented to the satisfaction of the Controller.

(5) The Controller may, for the purpose of the proper maintenance of a national park or nature reserve and for the protection of the safety of visitors thereto direct any wild animal to be removed from or taken away to such place as he may direct:

Provided that he shall not direct the removal of a totally protected animal or a protected animal without consultation with the Controller of Wild Life.

Appointment of managing agent.

25. (1) The Controller, with the approval of the Minister, may by order published in the Gazette, appoint any person or company (in this section described as a "managing agent"), to -

(a) build, manage or maintain;

(i) any of the building and facilities referred to in section 24(2); or

(ii) any historical site or historical monument within a national park or a nature reserve; or

(b) to undertake the provision of services, within a national park or nature reserve, which a licensed tour operator may, under the Tourism Industry Act, 1992, provide. Act 482.

(2) Such appointment shall be regulated by an agreement between the Controller and the person or company to be appointed under subsection (1). The agreement shall set out the duties and responsibilities of the managing agent and the terms, conditions and duration of his appointment.

PART V

OFFENCES AND PENALTIES

Restriction on certain acts in a national park or a nature reserve.

26. No person, other than a person acting under and in accordance with the permission of the Controller, shall -

(a) enter, reside or remain in a national park or nature reserve;

(b) convey into a national park or nature reserve or, within the confines thereof, be in possession of any weapon, explosive, poison or any contrivance of any kind used for the taking, capturing, shooting, killing or destroying of any animals;

(c) within a national park or nature reserve, kill, injure, capture or disturb any animal or take or destroy any plant, egg or nest;

(d) cut or set fire to any plant or damage any object of geological, prehistoric, archaeological, historical or other scientific interest;

(e) introduce any animal, or permit any domestic animal to stray, into a national park or nature reserve, or introduce any plant into a national park or nature reserve;

(f) remove from a national park or nature reserve any animal or plant, whether alive or dead, other than any animal or plant lawfully introduced into a national park or a nature reserve by the person removing it;

(g) remove from a national park or nature reserve any object of geological, prehistoric, archaeological, historical or other scientific interest;

(h) destroy or deface any object, whether animate or inanimate;

(i) erect any building in a national park or nature reserve;

(j) clear or break up any land in a national park or nature reserve;

(k) without prejudice to any rights lawfully acquired before 16th day of February 1956, and to the provisions of any law for the time being in force in Sarawak relating to mining, prospect for minerals in any national park or nature reserve;

(l) place, dump, deposit, ease or throw any carcass, paper, boxes, bottles, tins, refuse of any kind, noxious liquid or other offensive or filthy matter of any kind in a national park or nature reserve.

Power of arrest and search.

27. (1) Any park officer or police officer may, without a warrant, arrest any person who is reasonably suspected of having committed an offence against this Ordinance or any regulations made hereunder, if such person refuses to give his name and address or gives a name and address which there is reason to believe is false, or if there is reason to believe that he may escape.

(2) Every officer making an arrest under this section shall, without unnecessary delay, take or send the person arrested to the officer-in-charge of the nearest police station or to the Controller or any Park Warden empowered under section 28 to compound the offence:

Provided that in the latter case, if the arrested person refuses to compound the alleged offence, he shall forthwith be sent to the officer-in-charge of the nearest police station to be dealt with according to the law.

(3) Whenever a park officer or police officer has reasonable cause to suspect that an offence against this Ordinance or any regulations made hereunder, has been committed, he may search any conveyance, building or place under the control of the person suspected, his agents or servants.

Power to compound.

28. (1) The Controller or any other Park Warden specially authorized by him in writing may compound any offence under this Ordinance or any regulation made hereunder, by accepting from the person reasonably suspected of having committed such offence, a sum of money not exceeding one half of the maximum fine prescribed for the offence.

(2) On payment of such sum of money, the person shall be discharged and no further proceedings shall be taken against him, and such property, if any, (other than totally protected animals or plant or protected animal or plant or any recognizable part or derivative thereof) which has been confiscated as provided in this Part shall be disposed of in such manner as the officer shall think fit.

(3) All sums of money received in compensation under this section shall be credited to the State Consolidated Fund.

Power to hold inquiry and require attendance.

29. (1) Any park officer not below the rank of a Park Warden may, by notice in writing, require the attendance before him for purposes of investigation at a time and place to be specified in such notice, of any person suspected of being concerned in an offence against this Ordinance or any regulations made hereunder.

(2) If any such person refuses to attend as so required, the park officer may report the refusal to a Magistrate who may thereupon if he thinks fit, issue a summons of warrant to secure the attendance of that person as required by that notice.

Power to seize property.

30. (1) Where there is reason to believe that an offence against this Ordinance or any regulations hereunder has been committed, any conveyance, plant, animal, or any part or derivative thereof, firearm, ammunition, appliance, weapon, trap, snare or any other object, article or thing which is the subject matter of or used in the commission of such offence, may be seized by any park officer or police officer.

(2) Every officer seizing any property under this section shall place on such property, a mark or label indicating that it has been so seized and shall without undue delay, make a report of such seizure to a Magistrate having jurisdiction to try the offence on account of which the seizure has been made:

Provided that, in any case where such property has been seized in connection with an offence dealt with under any regulations made under section 37(1) or committed by some person unknown or who cannot be found, it shall not be necessary to report to a Magistrate the seizure thereof and such property shall be taken possession of by the park officer who may after the expiration of one month, from the date of seizure thereof, dispose of the property in such manner as he shall think fit unless the property is subject to ready or natural decay, in which case a Chief Park Warden may order its disposal immediately.

(3) When possession is taken of any property of a person which is unknown or who cannot be found under subsection (2), the park officer so taking possession shall either cause a notice thereof to be served upon any person whom he has reason to suspect to be interested in the property, or publish such notice in any way he thinks fit.

Disposal of confiscated property by Court.

31. When the trial of any offence under this Ordinance, or any regulations made thereunder, is concluded, any property that has been seized under the provisions of this Ordinance shall, if they are the property of the Government, be delivered to such park officer as the court may order and, in any other case, may be forfeited to the Government or otherwise disposed of as the court may order.

Offences and penalties.

32. Any person who contravenes -

(a) any provision of this Ordinance or any regulation made hereunder, where no specific penalty is stipulated; or

(b) any order made by the Controller pursuant to this Ordinance; or

(c) any direction given by the Controller or a Chief Park Warden,

shall be guilty of an offence. Penalty: a fine of five thousand ringgit or imprisonment up to a period of one year or to both fine and imprisonment.

Eviction from a national park or a nature reserve.

33. (1) When any person is convicted of an offence against the provisions of this Ordinance, the court shall, if application is made to it in that behalf by or on behalf of the Controller, issue a warrant addressed to all police officers or park officers requiring them forthwith to evict or remove such person from the national park or nature reserve in which the offence was committed, and to take possession on behalf of the Government, of all animals, plants, crops, buildings, instruments, weapons, machines and any other property used in the commission of the offences and the persons to whom such warrant is addressed shall forthwith carry the same into execution.

(2) An application under subsection (1) may be made without further process if made before the court recording a conviction adjourns but, if not so made, shall be made by summons before that court and the court shall make no further order unless proof of the service of such summons upon the person convicted is forthcoming.

Park officer to exercise powers of eviction, etc.

34. (1) Where there is reason to believe that an offence against the provisions of section 26 has been committed, the Chief Park Warden or any park officer duly authorized in writing in that behalf by the Controller may –

(a) remove from the national park or nature reserve any person whom he has reason to believe to be committing the offences;

(b) seize any animal, plant, vehicle, vessel, machine, instrument, weapon, trap, snare or other implement or thing which he has reason to believe was used or is being used in the commission of the offence; and

(c) demolish or remove any building or structure or take possession in the name of the Government all buildings, structure, machines, crops and other property.

(2) No park officer or police officer shall be liable for any injury, loss or damage caused to any person consequent upon his taking the steps mentioned in subsection (1).

(3) Every officer in the exercise of the powers conferred under subsection (1) may call upon any police officer or park officer for assistance and it shall be the duty of every such officer to comply with such request.

Abetment and attempt.

35. Any person who abets or attempts to commit an offence under this Ordinance is guilty of an offence and shall on conviction, be liable to the same penalty provided for the principal offence.

Power to conduct prosecutions.

36. Prosecutions for offences against this Ordinance or any regulations made hereunder may be conducted by the Public Prosecutor or any person authorized in writing by him under section 377 of the Criminal Procedure Code. FMS Cap.6.

PART VI

GENERAL

Regulations.

37. (1) Majlis Mesyuarat Kerajaan Negeri may make regulations generally for carrying out the provisions of this Ordinance and in particular such regulations may provide for –

(a) the powers and duties of a park officer in regard to –

(i) the exclusion of members of the public from a national park or nature reserve or any part thereof;

(ii) the killing, capturing or impounding of any animals within a national park or nature reserve and the disposal of such animals;

(iii) the burning and cutting of plants within a national park or nature reserve; and

(iv) the disposal of animal, plant, mineral or other product of the national park or nature reserve;

(b) regulating and controlling the taking, hunting, killing, snaring, trapping or capturing any kind of wild life by people with subsisting rights and privileges in a national park or nature reserve, and regulating and controlling the type of weapons, instruments, contrivances and various other methods which may be used by such people in the taking, shooting or killing of wild life;

(c) regulating the activities which can be undertaken for research and other scientific or other purposes inside national parks and nature reserves;

(d) prescribing the powers, duties, responsibilities and other activities of a Special Park Committee;

(e) incentives by way of grants or other forms of monetary rewards, to any person or body of persons involved in the supervision, control and management of a national park or nature reserve and the protection of wild life, geological and physiographical features therein or to any person who provides information leading to the conviction of any person of any offence under this Ordinance;

(f) compensation for any interference with the exercise of any rights or privileges recognised under section 11 within a national park;

(g) the conditions subject to which permission to enter a national park may be granted, and the periods or times during which a national park or any part thereof shall be open to the public;

(h) the conditions under which the services or attendance of park officers, or the services or attendance of any other person licensed by the Controller, may be obtained by any person entering, passing through or so journeying within a national park or nature reserve, and the fees to be paid for such services or attendance;

(i) the fees for admission in respect of persons and vehicles entering a national park or nature reserve, the taking of photographs therein and the circumstances and conditions under which such fees may be waived or reduced;

(j) the protection and preservation of a national park or nature reserve and the wild life therein;

(k) the regulation of traffic in and over a national park or nature reserve, the carriage of passengers, goods and weapons in a national park or nature reserve and the points at which people may enter a national park or nature reserve;

(l) the conditions under which, and the persons or officers by whom, in contravention of the provisions of this Ordinance or any regulations made hereunder may be compounded;

(m) procedure and forms for compounding of offences;

(n) the demarcation of specific areas within a national park or nature reserve for the exercise of any rights or privileges recognised under this Ordinance;

(o) the role and responsibilities of a managing agent appointed under section 25(1);

(p) anything that may be or is required to be prescribed under this Ordinance.

(2) Any regulations made under subsection (1) may provide for the punishment of any contravention thereof by penalties not exceeding a fine of five thousand ringgit or imprisonment not exceeding one year.

Repeal and saving.

38. (1) The National Parks and Nature Reserves Ordinance is hereby repealed. Cap.127 (1958 Ed).

(2) Nothing in this Ordinance shall affect the past operation of, or anything done under, the repealed Ordinance and any national park or nature reserve constituted under Part II thereof shall be deemed to have been constituted under and be subject to the provisions of this Ordinance.

(3) Any regulation, order, direction, notice, notification or proclamation made, issued, given or published under the repealed Ordinance and is still in force immediately before the date of commencement of this Ordinance shall continue to be in force and have full effect until such regulation, order, direction, notice, notification or proclamation, as the case may be, is amended, revoked or replaced under any corresponding provision of this Ordinance.

(4) Any action, suit, claim, proceedings or inquiry which has been instituted, filed, commenced or made under the repealed Ordinance and is still pending or existing immediately before the date of commencement of this Ordinance shall be continued and be determined or completed in all respects under the provisions of the repealed Ordinance as if this Ordinance had not been enacted.

APPENDIX 13 : THE WILDLIFE PROTECTION ORDINANCE

30.3.98

A Bill

intituled

An Ordinance to provide better provisions for the protection of wild life, the establishment and management of Wild Life Sanctuaries and all matters ancillary thereto.

Enacted by the Legislature of Sarawak -

PART I
PRELIMINARY

Short title and commencement.

1. This Ordinance may be cited as the Wild Life Protection Ordinance, 1998, and shall come into force on such date as the Minister may, by notification in the Gazette, appoint.

Interpretation.

2. (1) In this Ordinance -
"animal" means any species of animal and includes mammals, birds, reptiles, amphibians, fish, invertebrates, or any recognizable part or derivative thereof;

"building" includes any house, hut, shed, or roofed enclosure, whether used for the purpose of human habitation or otherwise, and also any wall, fence, platform, staging, gate, post, pillar, paling, frame, hoarding, slip, dock, wharf, pier, jetty, landing-stage or bridge, or any structure, support or foundation connected to the foregoing;

"Chief Wild Life Warden" means a Chief Wild Life Warden appointed under section 3(2);

"CITES" means the Convention on International Trade in Endangered Species of Wild Flora and Fauna signed at Washington D.C. on 3rd March, 1973 and which came into force on 1st July, 1975;

"Controller" means the Controller of Wild Life appointed under section 3 and includes a Deputy Controller;

"cultivated plant" means any plant which has been brought into cultivation and has been selectively bred;

"export" means export from the State of Sarawak;

"forest produce" has the meaning assigned to it in the Forests Ordinance;

"forest reserve" means a forest reserve constituted under Part II of the Forests Ordinance;

"Honorary Wild Life Ranger" means an Honorary Wild Life Ranger appointed under section 8;

Cap. 126. (1958 Ed.).

"hunt", "kill", "capture" mean hunting, killing or capturing by any method, and includes attempts to kill or capture, and the taking or disturbing of nests or eggs;

"import" means import into the State of Sarawak;

"Minister" means the Minister for the time being having the responsibility for wild life protection;

"National Park" and "Nature Reserve" shall have the same meanings assigned to these expressions in the National Parks and Nature Reserves Ordinance; Cap. 127. (1958 Ed.).

"nest" means —

(a) in relation to a wild animal, any abode den or lair or any other structure (whether of the same genus or not) which is being constructed or is being used by wild animals for –

(i) the procreation or spawning;

(ii) the protection; or

(iii) the nurture;

of immature wild animals or the eggs of wild animals; and

(b) in relation to a wild bird, any structure or device which is being constructed or is being used by wild bird for —

(i) the laying of their eggs;

(ii) the incubation of their eggs; or

(iii) the protection or nurture of immature wild birds;

"occupier" means any person in actual occupation of land and, in the case of land reserved or allocated for the use of a native community, includes the head of the community;

"owner" means the person in whose name the title to any land is registered and includes any person, other than the Government, who receives or is entitled to receive the rent or profits of any land whether on his own account or on behalf of himself and others or as agent;

"plant" means any species of plant, including all flowering and non-flowering species, or any recognizable part or derivative thereof;

"protected animal" means any animal specified in Part II of the First Schedule;

"protected plant" means any plant specified in Part II of the Second Schedule;

"Ranger" means a Wild Life Ranger appointed under section 3(2);

"shoot" includes shooting at;

"State land" has the meaning assigned to it in the Land Code; Cap.81 (1958 Ed.).

"this Ordinance" includes any subsidiary legislation made under this Ordinance;

"totally protected animal" means any animal specified in Part I of the First Schedule;

"totally protected plant" means any plant specified in Part I of the Second Schedule;

"transport" means to carry in, by or on a bicycle or any form of motorized vehicle or craft, including lorry, articulated lorry, truck, van, 4-wheel drive, car, motorbike, motor scooter, express boat or any other type of boat, aeroplane or helicopter;

"Warden" means a Wild Life Warden appointed under section 3(2);

"wild animal" means any species of animal which exists or occurs in the wild state in Sarawak or elsewhere in the world;

"wild life" means any species of wild animal or wild plant;

"Wild Life Officer" means any officer appointed under section 3(1) and (2) and includes an Honorary Wild Life Ranger appointed under section 8;

"Wild Life Sanctuary" means any area of land (including any marine, estuarine or freshwater areas) constituted as Wild Life Sanctuaries under the provisions of Part III;

"wild plant" means any species of plant which exists or occurs in the wild state in Sarawak or elsewhere in the world.

(2) A reference in this Ordinance to the "Yang di Pertua Negeri" shall be construed as a reference to the Yang di Pertua Negeri acting in accordance with the advice of the Majlis Mesyuarat Kerajaan Negeri or a member thereof acting under the general authority of the Majlis.

PART II

ADMINISTRATION

Appointment of Controller of Wild Life and other officers.

3. (1) The Minister may appoint a Controller of Wild Life from among members of the public service of the State for the purpose of performing the functions and duties assigned to him under this Ordinance.

(2) The Minister may appoint a Deputy Controller of Wild Life, and such number of Chief Wild Life Wardens, Wild Life Wardens, Wild Life Rangers and such other officers as may be considered necessary for carrying out the purposes of this Ordinance.

(3) All officers appointed under subsection (2) shall be subject to the control, direction and supervision of the Controller.

(4) All officers appointed under this Ordinance shall be deemed to be public servants within the meaning of the Penal Code. Act 574.

Functions and duties of Controller.

4. (1) The Controller shall -

(a) be responsible for the administration and enforcement of this Ordinance;

(b) exercise supervision and control of, and manage, Wild Life Sanctuaries;

(c) subject to the provisions of this Ordinance, protect and develop schemes and policies for the protection of wild life and their habitat in the State;

(d) regulate and control trade in wild life and the import and export thereof;

(e) obtain information on and keep records and data on wild life, the export and import thereof and the wild life and activities in Wild Life Sanctuaries;

(f) perform such functions in relation to this Ordinance as the Minister may from time to time determine; and

(g) carry on such other activities as may appear to the Controller, in consultation with the Minister, requisite, advantageous or convenient for the purpose of carrying out the provisions of this Ordinance.

(2) The duties and functions of the Controller shall, subject to the direction of the Controller, be exercisable by the Deputy Controller.

(3) The Minister may give the Controller such directions, not inconsistent with the provisions of this Ordinance, as he thinks fit, as to the exercise and performance of his duties and functions under this Ordinance, and the Controller shall give effect to all such directions.

Delegation of functions by the Controller.

5. The Controller may, in writing, delegate to any officer under his control, direction and supervision the exercise or performance, subject to such conditions, limitations or restrictions as may be provided in the instrument of delegation, any of his functions or duties assigned to him under this Ordinance:

Provided that any delegation under this section with respect of any function or duty shall not prevent the Controller from himself exercising or performing such delegated function or duty in any case where it appears expedient to do so.

Functions and duties of Chief Wild Life Warden.

6. (1) A Chief Wild Life Warden shall exercise the functions and duties assigned by the Controller to him in the geographical locality under his jurisdiction.

(2) A Chief Wild Life Warden shall report to the Controller any matter in respect of which any action on the part of the Controller is necessary.

(3) A Chief Wild Life Warden shall be vested with the functions and duties of a Warden or a Ranger.

Functions and duties of Wardens and Rangers.

7. (1) A Warden shall be responsible for the control and management of a Wild Life Sanctuary, and shall report to the Chief Wild Life Warden having jurisdiction over that Wild Life Sanctuary, pertaining to all activities and incidents occurring therein.

(2) A Warden shall be assisted in the discharge of his duties and functions by such numbers of Rangers as may be determined by the Controller.

Honorary Wild Life Ranger.

8. (1) The Minister may, from time to time, appoint any person to be an Honorary Wild Life Ranger.

(2) Such appointment shall be for such period and subject to such terms and conditions as may be stipulated in the instrument of appointment.

(3) An Honorary Wild Life Ranger shall have all the powers, duties and functions, as may be prescribed by rules made under this Ordinance.

Special Wild Life Committee.

9. (1) The Controller, with the approval of the Minister, may constitute a Special Wild Life Committee, which shall be headed by a Warden, to assist him in the supervision, control and management of a Wild Life Sanctuary and to protect the wild life and their habitat therein.

(2) A Special Wild Life Committee shall consist of not more than twelve members, and shall comprise Rangers, Honorary Wild Life Rangers and such other persons, residing near to a Wild Life Sanctuary, who, in the opinion of the Controller, would be able to assist him in the protection of wild life and the management of a Wild Life Sanctuary.

(3) A Special Wild Life Committee shall, in addition to assisting the Controller in the protection of wild life in the Wild Life Sanctuary, help to initiate and develop programmes for the maintenance of the Wild Life Sanctuary, the protection of animals and plants therein, and the enhancement of public interest and appreciation of wild life.

PART III

WILD LIFE SANCTUARIES

Constitution of Wild Life Sanctuary.

10. Subject to the provisions of this Part, a Wild Life Sanctuary may be constituted over any State land which is not part of a national park or a nature reserve.

Procedure for constituting a Wild Life Sanctuary.

11. (1) Where it is proposed to constitute a Wild Life Sanctuary over State land which is not within a forest reserve, the Minister shall publish in the Gazette, a notification -

(a) specifying as accurately as possible the description and limits of the land intended to be constituted as a Wild Life Sanctuary;

(b) directing any person claiming any right or privilege in or over such land to submit, within sixty days from the date of publication of such notification, to the Chief Wild Life Warden for the area in which the land is situated, his claim with evidence in support thereof; and

(c) stating that upon the expiry of a period of sixty days from the date of publication of the notification, no claim to any rights or privileges in or over the area intended to be constituted a wild life sanctuary shall be entertained and such rights or privileges, if any, shall be deemed to have been abandoned or the exercise thereof has been waived, by any person entitled thereto.

Rights or privileges.

(2) A copy of the notification shall be published in at least one newspaper circulating in Sarawak, and displayed at the District Office for the area to be constituted a Wild Life Sanctuary or be brought to the notice of the persons affected thereby in such manner as the Minister thinks necessary.

Claim.

12. The rights or privileges that may be recognised in an area to be constituted as a Wild Life Sanctuary shall be only those rights or privileges which have been enjoyed or exercised by or accrued to a native or his forefathers or a native community for an uninterrupted period beginning from a date prior to 1 January 1958 to the date of the notification referred to in section 11(1).

13. (1) A claim in respect of any right or privilege in or over the land to be constituted a Wild Life Sanctuary must be made in writing and in such form as may be prescribed to the Chief Wild Life Warden for the area where the land is situated.

(2) A claim to such right or privilege may be submitted by a Headman on behalf of any person claiming such right or privilege.

(3) Any person who fails to submit a claim to any right or privilege in or over the land to be constituted a Wild Life Sanctuary within the period stipulated in the notification, shall be deemed to have abandoned or waived such right or privilege and shall not be entitled to exercise the same after the constitution of the Wild Life Sanctuary.

Enquiry into claim.

14. (1) The Chief Wild Life Warden shall, within sixty days from the date of receipt of any claim submitted under section 13, or such extended period as may be approved by the Controller, conduct an enquiry into such claim.

(2) In any such enquiry, the onus of proving the existence of any right or privilege claimed shall be on the claimant.

(3) The Chief Wild Life Warden may call for and receive any evidence to verify, confirm or support any claim from any claimant or any public officer or any other person having knowledge of such claim. In the conduct of such enquiry, the Chief Wild Life Warden shall have the same powers to summon and examine witnesses as a Magistrate.

(4) Where it is considered necessary and expedient, any enquiry conducted pursuant to this section may be held in public at such time and on such date as may be specified in a notice to be issued by the Chief Wild Life Warden.

Report.

15. (1) The Chief Wild Life Warden shall, upon conclusion of the enquiry, furnish a report thereof to the Controller.

(2) The report shall contain the notes of proceedings and evidence recorded at the enquiry together with such findings and recommendations as the Chief Wild Life Warden may deem it fit or proper to make.

Rights or privileges admitted etc.

16. Where any right or privilege is admitted or found to have subsisted at the time of the publication of the notification under section 11, the Controller shall -

(a) regulate the exercise or enjoyment of such rights or privileges including directing the areas or places within a Wild Life Sanctuary where the rights or privileges may be exercised or enjoyed and the manner of exercising or enjoyment thereof; or

(b) with the approval of the Minister, proceed to extinguish such rights or privileges and pay compensation to the lawful claimant thereof or permit in consultation with the Director of Lands and Surveys, the exercise of such rights and privileges in any other area outside the Wild Life Sanctuary.

Assessment of compensation.

17. In assessing the compensation payable under this Part for the extinguishment of any right or privilege in or over the area constituted or to be constituted a wild life sanctuary, the Controller shall take into account the following -

(a) the nature and extent of the right or privilege claimed;

(b) whether such right or privilege is still exercised or enjoyed by the claimant at the date of notification published under section 11;

(c) the degree of actual dependency, if any, of the claimant on such right or privilege as a means of his livelihood;

(d) if the right or privilege relates to the planting of any crop, whether alternative site or area has been provided by the Government for the person or the community to which he belongs, for farming; and

(e) any other relevant factors or circumstances pertaining to the enjoyment or exercise of such right or privilege.

Decision on compensation.

18. The decision of the Controller on the compensation payable to any claimant under this Part shall be served on the claimant at the address provided by him at the time of submission of his claim or if his claim is submitted through his Headman, the decision shall be served on the claimant by handing a copy thereof to the Headman.

Appeal.

19. (1) Any person aggrieved by the decision of the Controller may, within thirty days from the date of service of the decision on him, appeal to a Sessions Court.

(2) An appeal to a Sessions Court shall be by way of originating application and shall follow the procedures prescribed by the Subordinate Courts Rules 1980. P.U.(A). 328/80.

(3) Subject to the Subordinate Courts Rules 1980, a Judge of the Sessions Court may give such direction as he may deem fit or necessary for the disposal or hearing of any appeal before him under this section.

Notification.

20. (1) At any time after the Controller has made a decision on the rights or privileges under section 16, the Minister may, with the approval of the Majlis Mesyuarat Kerajaan Negeri, publish in the Gazette, a notification to constitute the area specified in the notification referred to in section 11(1), a wild life sanctuary.

(2) Such notification shall -

(a) state the name of the wild life sanctuary;

(b) specify the limit of the wild life sanctuary;

(c) state the date on which the notification shall take effect;

(d) declare whether all rights or privileges in the wild life sanctuary have been extinguished; and

(e) stipulate the special conditions, if any, governing the reservation thereof.

Constitution of Wild Life Sanctuary over Forest

21. (1) The Minister may, with the approval of the Majlis Mesyuarat Kerajaan Negeri, by notification in the Gazette, constitute any area within a forest reserve to be a Wild Life Sanctuary.

(2) The notification under subsection (1) shall -

(a) state the name of the Wild Life Sanctuary;

(b) state the date on which the Wild Life Sanctuary is constituted;

(c) declare that area on which the Wild Life Sanctuary is to be constituted shall cease to be a forest reserve;

(d) provide a detailed description of the area to be constituted a Wild Life Sanctuary; and

(e) limit or prohibit the exercise or enjoyment of any subsisting rights and privileges in the area to be constituted a Wild Life Sanctuary.

(3) Any area constituted a wild life sanctuary pursuant to this section shall -.

(a) be deemed to have been ceased to be part of the forest reserve and the provisions of section 24(2) and (3) of the Forests Ordinance shall apply; and

(b) be managed, administered and controlled by the Controller, subject to such direction as may be given to him, by the Minister.

Effect of notification.

22. (1) From the date referred in the notification gazetted under section 20(1) or 21(1), no person shall -

(a) enter and remain in the Wild Life Sanctuary without the written permission of the Warden in charge thereof;

(b) exercise and enjoy any right or privilege in the wild life sanctuary, whether such right or privilege were awarded under any licence, permit, or accrued or recognised under any written law, except in accordance with the written directive or guidelines issued by the Controller; and

(c) undertake any activities, studies or research in the Wild Life Sanctuary without the prior written permission of the Controller.

(2) Any person who fails to comply with any of the provisions of subsection (1) may be removed or evicted from the Wild Life Sanctuary by the Warden or a police officer not below the rank of Inspector.

Alienated land.

23. (1) The inclusion of any alienated land in a Wild Life Sanctuary shall be deemed to be a public purpose within the meaning of section 46 of the Land Code.

(2) Where alienated land has been acquired for the purposes specified in subsection (1), the Minister may include the land so acquired in the notification made under section 20.

Acts prohibited in Wild Life Sanctuary.

24. (1) No person shall enter a Wild Life Sanctuary unless he first obtains a written permit from the Warden in charge thereof authorising him to do so.

(2) No person shall in a Wild Life Sanctuary -

(a) hunt, kill or capture any animal;

(b) keep or carry any weapon, contrivance or material of any kind used for the taking, shooting or killing of any animal;

(c) be in possession of, or use, any form of trap, snare, net or other contrivance for trapping or snaring animals. The only exception are nets being used for fishing by people with subsisting rights or privileges;

(d) cut, collect, remove or be in possession of any wild plant or any part thereof;

(e) be in possession of any wild animal or any recognisable part or derivative thereof;

(f) quarry stone, burn lime or charcoal, or search for, collect or remove any minerals, stone, or any other material;

(g) erect any building or structure, or break up any land for cultivation or for any other purpose; or

(h) kindle or ignite any fire or leave a fire burning.

(3) Whoever does any act in contravention of paragraph (a) or (e) of subsection (2) shall be guilty of an offence. Penalty -

(a) if the animal concerned is a rhinoceros, imprisonment for five years and a fine of fifty thousand ringgit

(b) if the animal concerned is an orang utan or proboscis monkey, imprisonment for two years and a fine of thirty thousand ringgit;

(c) if the animal concerned is a totally protected animal other than those mentioned in paragraph (a) or (b), imprisonment for two years and a fine of twenty-five thousand ringgit;

(d) if the animal concerned is a protected animal, imprisonment for one year and a fine of ten thousand ringgit;

(e) in the case of any other animal not mentioned in paragraphs (a), (b), (c) and (d), imprisonment for one year and a fine of two thousand ringgit or five times the sum which appears to the court to be the value of the wild animal hunted, captured or killed, whichever is the greater.

(4) Whoever does any act in contravention of paragraph (d) of subsection (2) shall be guilty of an offence. Penalty -

(a) if the plant concerned is a totally protected plant, imprisonment for two years and a fine of twenty-five thousand ringgit;

(b) if the plant concerned is a protected plant, imprisonment for one year and a fine of ten thousand ringgit;

(c) in the case of other wild plant not being a totally protected plant or protected plant, imprisonment for one year and a fine of two thousand ringgit or five times the sum which appears to the court to be the value of the wild plant cut or removed, whichever is the greater.

(5) Whoever does any act in contravention of subsection (1), or paragraphs (b), (c), (f), (g) and (h) of subsection (2), shall be guilty of an offence. Penalty - imprisonment for one year and a fine of five thousand ringgit.

(6) No road or railway shall be built within the boundaries of a Wild Life Sanctuary, except with the written permission of the Minister.

(7) Before any written permission is given under subsection (6), the Minister shall be satisfied that -

(a) the construction of such road or railway through a Wild Life Sanctuary is essential and in the public interests;

(b) there is no alternative route or site for such road or railway outside the Wild Life Sanctuary;

(c) an environmental impact assessment of such road or railway through a Wild Life Sanctuary has been undertaken and approved by the Natural Resources and Environment Board constituted under the Natural Resources and Environmental Ordinance, and that all conditions and measures to mitigate against any adverse environmental impact have been complied with, or implemented, in the construction of the roads or railways. Cap. 84. (1958 Ed.).

Saving.

25. (1) Nothing in paragraphs (a), (b), (c), (d), (e), (g) and (h) of subsection (2) of section 24 shall be deemed to prohibit or render punishable the exercise of any right or the enjoyment of any privilege established or acquired under the provisions of this Ordinance or any written law repealed by this Ordinance.

(2) Nothing in paragraphs (a), (b), (c), (d), (e) and (g) of subsection 2 of section 24 shall be deemed to prohibit or render punishable any act done, with the permission in writing of the Controller, for scientific or educational purposes or for the protection, conservation and management of wild life.

Controller or authorised officer to exercise powers to evict.

26. (1) Where there is reason to believe that an offence against subsection (1) or (2) of section 24 has been committed, the Chief Wild Life Warden or Warden or any person authorised by the Controller, or a police officer not below the rank of Inspector, may -

(a) remove from the Wild Life Sanctuary any person whom he has reason to believe to have committed the offence;

(b) seize all instruments, machinery, weapons, implements, forest produce, minerals, chemicals and any other object or item which he has reason to believe was used or is being used in the commission of the offence; and

(c) demolish or remove any building, structure, barrier or obstruction, or take into possession in the name of the Government all buildings, animals, plants, crops and any other property.

(2) Every officer in the exercise of the powers conferred under subsection (1) may call upon any police officer for assistance and it shall be the duty of every such police officer to comply with such request.

Termination of Wild Life Sanctuary.

27. (1) The Yang di-Pertua Negeri may, by Order published in the Gazette, direct that, from a date to be fixed by such notification, any Wild Life Sanctuary, or any part thereof, shall cease to be a Wild Life Sanctuary.

(2) From the date so fixed, the Wild Life Sanctuary or any part thereof shall cease to be a Wild Life Sanctuary and become unalienated State land.

Right to protect wild life in special areas.

28. (1) Where the Minister is of the opinion that any area of land is of special interest by reason of its wild life or geological or physiographical features, he may order the owner or occupier of the land -

(a) to undertake or adopt such measures as he may deem necessary for the conservation of wild life or geological or physiographical features in the areas;

(b) to take appropriate measures for the protection of wild animals and wild plants and to ensure sufficient habitat for their survival; and

(c) not to hunt, kill, trap, snare or capture any wild animal, or destroy, cut, collect, uproot or remove any wild plant, forest produce, soil, rock, peat, clay, minerals or any geological substrata.

(2) Such order may relate to -

(a) the prohibition, restriction or control of the burning, clearing, collecting, damaging or destruction of wild plants;

(b) the restriction or control of removing or felling of timber or any forest produce;

(c) the prohibition, restriction or control of hunting, killing, capturing, shooting, netting, trapping, snaring, fishing or taking of any wild animal;

(d) the preservation and protection of wild life or geological or physiographical features;

(e) the exercise of any rights over the land;

(f) the doing or abstaining from doing any act which in the opinion of the Minister is necessary for the conservation of wild life or geological or physiographical features of the land.

(3) Before making an order under subsection (1), the Minister shall cause the Controller to -

(a) make arrangement or agreement with the owner or occupier of the land with a view to compensation and to carry out all such works in respect of the land as may be necessary for the protection or conservation of its wild life or geological or physiographical features; the agreement may impose restrictions or obligations as respects the method of cultivating the land, its use for agriculture or forestry purposes or any other usage or the exercise of rights over the land; or

(b) where it is not possible to come to an arrangement or agreement with the owner or occupier of the land, enforce the provisions of this section by serving on the owner or occupier of the land on whom the order is to be addressed a notice in writing setting out the measures to be taken as stated in the order and specifying the time (not being less than one month from the date of the giving of the notice) within which and the manner in which representations or objections with respect thereto may be made to the Yang di-Pertua Negeri whose decision shall be final and conclusive, and shall not be challenged, appealed against, reviewed, quashed or called into question in any court or before any other authority, judicial or otherwise, whatsoever.

(4) The Yang di-Pertua Negeri shall consider any representations or objections duly made with or without modifications or direct that the order shall not be proceeded with.

(5) Any order under subsection (1) shall specify -

(a) the wild life or geological or physiographical features by reason of which the land is of special interest; and

(b) any activities or operations appearing to the Minister to be likely to damage or cause harm to that wild life or geological or physiographic features.

(6) Any owner or occupier of land who, without the permission in writing of the Minister or any officer authorized in writing in that behalf by the Minister, contravenes, fails or neglects to carry out any order made under subsection (1) or acts in breach of the provisions of an arrangement or agreement made under subsection (3), shall be guilty of an offence. Penalty - imprisonment for one year and a fine of two thousand ringgit or five times the sum which appears to the court to be the value of any wild life killed, captured, collected or damaged, or of any stone or other materials removed, whichever is the greater.

(7) The Controller may pay to the owner or occupier of the land such compensation as may be agreed upon between the parties or, in default of such agreement, by submission to arbitration under the law relating to arbitration for the time being in force in Sarawak.

PART IV

PROTECTION OF WILD LIFE

Totally protected animals and protected animals.

29. (1) No person shall hunt, kill, capture, sell, offer for sale or claim to be offering for sale, import, export, or be in possession of, any totally protected animal or any recognizable part or derivative thereof, or any nest thereof, except in accordance with the permission in writing of the Controller for scientific or educational purposes or for the protection and conservation of such wild animal. Penalty -

(a) if the animal concerned is a rhinoceros, imprisonment for five years and a fine of fifty thousand ringgit;

(b) if the animal concerned is an orang-utan or proboscis monkey, imprisonment for two years and a fine of thirty thousand ringgit;

(c) in the case of other totally protected animals not mentioned in paragraph (a) or (b), imprisonment for two years and a fine of twenty-five thousand ringgit.

(2) No person shall hunt, kill, capture, sell, offer for sale or claim to be offering for sale, import, export, or be in possession of, any protected animal or any recognizable part or derivative thereof, or any nest thereof, except in accordance with the terms and conditions of a licence issued under this Ordinance. Penalty - imprisonment for one year and a fine of ten thousand ringgit.

Totally protected plants and protected plants.

30. (1) Without prejudice to section 24(4), no person shall collect, cultivate, cut, trim, remove, burn, poison, injure, sell, offer for sale, import, export or be in possession of, any totally protected plant or any recognizable part or derivative thereof except in accordance with the permission in writing of the Controller for scientific or educational purposes or for the protection and conservation of such wild plant. Penalty -imprisonment for two years and a fine of twenty-five thousand ringgit.

(2) No person shall collect, cultivate, cut, trim, remove, burn, poison, in any way injure, sell, offer for sale, import, export or be in possession of , any protected plant or any recognizable part or derivative thereof except under and in accordance with the terms and conditions of a licence issued under this Ordinance. Penalty - imprisonment for one year and a fine of ten thousand ringgit.

Licence to import and export wild animals and wild plants.

31. No person shall import into or export out of Sarawak any wild animal specified in Part III of the First Schedule or any wild plant except under and in accordance with the terms and conditions of a licence issued by the Controller. Penalty - imprisonment for one year and a fine of two thousand ringgit or five times the sum which appears to the court to be the value of any wild animal or wild plant imported or exported, whichever is the greater.

Use of mist nets.

32. (1) No person shall sell mist nets for the catching of mammals or birds without a licence issued by the Controller. Penalty - imprisonment for three months and a fine of one thousand ringgit.

(2) No person shall use mist nets to catch any mammal or bird except in accordance with the terms and conditions of a licence issued by the Controller. Penalty - imprisonment for six months and a fine of two thousand ringgit.

(3) All licences issued under this section shall be subject to such terms and conditions as may be imposed by the Controller.

Commercial sale of wild animal.

33. (1) Without prejudice to section 29, no person shall sell or offer for sale or claim to be offering for sale, any wild mammal, bird, reptile or amphibian or any recognizable part or derivative thereof other than a wild mammal, bird, reptile or amphibian which is bred, reared or kept in accordance with a licence issued undersection 35.

(2) No person shall collect, sell, offer for sale or export from or import into the State, any nest of any swiflets or any recognisable part or derivative thereof without a licence from the Controller.

(3) Any person who contravenes subsection (1) or (2), or who fails to comply with any condition imposed in a licence issued by the Controller for the purposes of subsection (2), shall be guilty of an offence. Penalty - a fine of five thousand ringgit.

Prohibition against purchase of wild animal etc.

34. Any person who buys -

(a) any wild animal or part or derivative thereof which is sold or offered for sale in contravention of section 33(1); or

(b) any nest of swiflets which is offered for sale in contravention of section 33(2),

shall be guilty of an offence: Penalty, a fine of two thousand ringgit.

Licence for breeding of wild animals.

35. (1) No person shall breed, rear or keep any wild mammal, bird, reptile or amphibian for the purpose of trade, sale or commercial usage without a licence from the Controller.

(2) The sale or offer for sale of any wild mammal, bird, reptile or amphibian bred, reared or kept pursuant to subsection (1) shall be regulated -

(a) by conditions imposed in the licence issued thereunder; or

(b) where the sale or offer for sale is not carried out by the holder of a licence issued under subsection (1), in accordance with a licence for sale issued by the Controller.

(3) Any person who contravenes subsection (1) or (2) or any condition of a licence issued for the purpose stipulated thereunder shall be guilty of an offence: Penalty, imprisonment for one year and a fine of ten thousand ringgit.

Display and production of licence.

36. (1) The holder of any licence issued under section 33(2) or 35 shall display the licence in a prominent place in his business premises where the public has access, and shall upon request by a Wild Life Officer, a police officer or any person intending to make any purchase of wild animal or nest from him, produce his licence for inspection.

(2) Upon request by a Wild Life Officer, police officer or any person intending to make any purcahse of wild animal, the holder of a licence referred to in subsection (1), must disclose and provide satisfactory proof of where he obtained the wild animal or nest or the origin thereof.

(3) Any licence holder who contravenes subsection (1) or (2) shall be guilty of an offence: Penalty, a fine of two thousand ringgit.

Possession of wild life.

37. (1) No person shall, unless licensed under this Ordinance, have in his possession any species of wild mammal, bird, reptile or amphibian -

Provided that -

(a) a native residing within a Native Area Land or Native Customary Land may have in his possession, for his own consumption or use any wild mammal, reptile or amphibian or other recognisable part or derivative thereof; and

(b) any other person may have, for his own consumption not more than five kilograms of wild mammal, bird, reptile or amphibian.

(2) Any person who contravenes subsection (1) shall be guilty of an offence. Penalty -

(a) if the animal concerned is a totally protected species, the penalty shall follow those specified in subsection (1) of section 29 per individual animal and animal part in his possession;

(b) if the animal concerned is a protected species, the penalty shall follow those specified in subsection (2) of section 29 per individual animal and animal part in his possession;

(c) for all other species, the penalty shall be imprisonment for one year and a fine of two thousand ringgit per individual animal and animal part found in his possession.

(3) Any person having in possession any wild mammal, bird, reptile or amphibian exceeding the quantities stipulated in proviso (a) or (b) of subsection (1), shall be deemed to have intended to sell or offer for sale such wild mammal, bird, reptile or amphibian, and be guilty of an offence under section 33(1).

(4) The terms "Native Area Land" and "Native Customary Land" in subsection (1) shall have the same meaning assigned thereto in the Land Code. Cap. 81. (1958 Ed.).

Onus of proving lawful acquisition.

38. In any prosecution under section 29, 30, 33, 34 or 37, the onus of proving lawful acquisition or possession shall be upon the person in possession of the wild animal or wild plant or recognizable part or derivative thereof.

Exemption.

39. The Minister may exempt any public officer acting in the course of his official or statutory duties and functions from the provisions of section 29, 30, 34 or 37 in regard to the taking, possession and transport of turtles or their eggs, or other wild animal or wild plant or any recognizable part or derivative thereof.

Licences.

40. (1) Licences required under this Ordinance may be issued by the Controller or any officer duly authorized in writing in that behalf by him, and subject to such conditions which the Controller or any such officer thinks fit to impose, and in such form as may be prescribed by the Controller.

(2) Licences issued under this Ordinance shall be for a period not exceeding one year unless otherwise expressly stipulated in the licence.

(3) Such licences shall not be transfered, sublet or assigned to any other person.

(4) Fees at the rates prescribed by rules made under section 55 shall be payable when such licence is issued, and no fee shall be refunded if the act authorized by such licence is not performed.

(5) The holder of any licence shall carry such licence on his person when performing any act authorized by it, and shall produce it for inspection on the demand of a Wild Life Officer.

(6) Any licence issued under this Ordinance shall be available only for the locality specified therein.

(7) The holder of any licence issued under this Ordinance shall, as soon as such licence expires or is otherwise determined, return it to a Wild Life Officer at the place where it was issued.

(8) Any person who fails to comply with subsection (3) orany condition of the licence issued under this Ordinance, shall be guilty of an offence. Penalty - imprisonment for three months and a fine of one thousand ringgit.

Destruction of dangerous or wounded animals.

41. (1) Any Warden or any person authorized by him may -

(a) hunt, kill or capture any animal which a Chief Wild Life Warden has declared to be dangerous to life or property; and

(b) hunt, kill or capture any animal in order to prevent unnecessary suffering on the part of such animal.

Right of defence of person and property.

42. (1) Nothing in this Ordinance shall be deemed to affect the right of any person to act in defence of his person, or the person of others, if in threat of imminent danger of severe bodily injury, or in the defence of serious damage to the property of that person or others:

Provided that if, in the exercise of any such right, he kills, captures or injures any totally protected animal or protected animal, he shall as soon as possible give information of the fact to the nearest Wild Life Officer.

(2) Failure to give the information required by subsection (1) shall constitute an offence. Penalty - imprisonment for three months and a fine of one thousand ringgit.

Recognisable parts or derivatives of animal and young animals found.

43. (1) Any person finding any recognizable part or derivative of a totally protected or protected animal shall, as soon as may be, deliver or give notice of the finding of such recognizable part or derivative to the nearest Wild Life Officer, and such recognizable part or derivative shall be disposed of in such manner as the Controller may direct.

(2) Any person who, upon finding the progeny of any totally protected animal or protected animal, has reason to believe that that progeny should still be under the care of its mother but that such care is not being afforded, shall as soon as may be, either deliver the animal to the nearest Wild Life Officer or furnish him with all such particulars as may be necessary to enable that officer to effect capture, and the animal shall be disposed of in such manner as the Controller may direct

(3) Any person who contravenes subsection (1) or (2) commits an offence. Penalty - imprisonment for three months and a fine of one thousand ringgit

Prevention of cruelty to wild animals.

44. Save as otherwise provided for in this Ordinance, any person who -

(a) beats, kicks, harms, terrifies or tortures any wild animal;

(b) neglects to supply sufficient food or water to any wild animal which he houses, confines or breeds;

(c) houses, confines or breeds any wild animal in such a manner so as to cause it unnecessary pain or suffering including the housing, confining or breeding of any wild animal in any cage, enclosure or hut which is not suitable for or conducive to the health of the wild animal;

(d) uses any wild animal for performing or assisting in the performance of any work or labour which is beyond its reasonable capacity or by reason of any infirmity, wound, disease or any other incapacity it is unfit to perform;

(e) incites, provokes or infuriates any wild animal for the purpose of baiting it or for fighting it with any other animal or owns and manages any premises or place for any of these purposes;

(f) wilfully does anything which in any way cause any unnecessary suffering, pain or discomfort to any wild animal;

(g) wilfully omits to do anything to prevent any unnecessary suffering, pain or discomfort to any wild animal; shall be guilty of an offence. Penalty - imprisonment for six months or a fine of two thousand ringgit or to both fine and imprisonment.

PART V

PROVISIONS AS TO PROCEDURE AND TRIALS

Power of arrest and search.

45. (1) Any Wild Life Officer, police officer or customs officer may, without warrant, arrest any person who is reasonably suspected of having committed an offence against this Ordinance, if such person refuses to give his name and address, or gives a name and address which the officer has reasonable grounds for believing to be false, or if such officer has reasonable grounds for believing that, unless such person is arrested, he may escape, or that an unreasonable amount of delay, trouble or expense in making him answerable to justice will ensue.

(2) Every officer making an arrest under this section shall, without unnecessary delay, take or send the person arrested to the officer in charge of the nearest police station, or to an officer empowered to compound the offence in accordance with section 47.

(3) Whenever a Wild Life Officer, police officer or customs officer has reasonable cause to suspect that an offence under this Ordinance has been committed, he may enter upon any land or premises for the purposes of carrying out the provisions of this Ordinance, or for the purpose of preventing or detecting offences under this Ordinance, and may search any vessel, vehicle, building, enclosure or place under the control of the person suspected, his agents or servants:

Provided that no woman shall be searched under this subsection except by a woman.

Power to hold inquiries and require attendance.

46. (1) Any Wild Life Officer not below the rank of Chief Wild Life Warden may, by notice in writing, require the attendance before him for the purposes of investigation, at a time and place to be specified in the notice, of any person suspected of being concerned in an offence under this Ordinance.

(2) If any person refuses to attend as so required by the Wild Life Officer he may report the refusal to a Magistrate who may thereupon, if he thinks fit, issue a summons or warrant to secure the attendance of that person as required by the notice.

Power to compound offences.

47. (1) The Controller or any other Wild Life Officer specially authorised by him in writing may compounded any offence under this Ordinance, other than offences against -

(a) section 24(3)(a), (b) and (c);

(b) section 29(1);

(c) section 30(1); and

(d) section 37(2) (a),

by accepting from the person reasonably suspected of having committed such offence a sum of money not exceeding one thousand ringgit.

(2) On the payment of such sum of money, the person shall be discharged and no further proceedings shall be taken against him, and such property, if any (other than totally protected animal or protected animal or any recognizable part or derivative thereof or totally protected plant or protected plant or any recognizable part or derivative thereof) which has been confiscated as provided in this Part shall be disposed of in such manner as the officer concerned shall think fit.

(3) All sums of money received in compensation under this section shall be credited to the State Consolidated Fund.

Power to seize property.

48. (1) Where there is reason to believe that an offence under this Ordinance has been committed, any animal or any recognizable part or derivative thereof, or plant or any recognizable part or derivative thereof, together with all weapons, instruments, machinery and contrivances used in the commission of such offence, may be seized by any Wild Life Officer, police officer or customs officer.

(2) Every officer seizing any property under this section shall place on such property, or on the receptacle, if any, in which it has been contained, a mark indicating that it has been so seized, and shall, without unnecessary delay, make a report of such seizure to a Magistrate having jurisdiction to try the offence in respect of which the seizure has been made:

Provided that, in any case where such property has been seized in connection with an offence compounded under section 51, it shall not be necessary to report to a Magistrate the seizure thereof, and such property shall be disposed of in such manner as the Controller shall think fit.

Seizure of property when offender cannot be found.

49. Where there is reason to believe that an offence under this Ordinance has been committed by a person who is unknown or cannot be found, all property seized under section 48 in respect of the offence shall be taken possession of by a Wild Life Officer not below the rank of Chief Wild Life Warden who shall report the seizure to a Magistrate, and the Magistrate shall deal with the property as if it were the subject of a report to him under section 413 of the Criminal Procedure Code. F.M.S. Cap. 6.

Disposal of property.

50. Where the trial of any offence under this Ordinance is concluded, any property that has been seized in relation thereto shall be disposed of as the court may order.

Double penalty in certain cases.

51. Any person who commits an offence against this Ordinance or any rule made thereunder -

(a) after sunset and before sunrise; or

(b) after a previous conviction for a like offence; shall be liable to double the penalty prescribed for such offence.

Who may prosecute.

52. Prosecutions in respect of offences committed under this Ordinance or any rule made thereunder may be conducted by the Public Prosecutor or any person authorised in writing by him under section 377 of the Criminal Procedure Code.

Protection of informers from discovery.

53. (1) Except as herein provided, no witness in any proceedings under this Ordinance shall be obliged or permitted to disclose the name and address of any informer, or the substance of the information received from him, or to state any matter which might lead to his discovery.

(2) If any books, documents or papers which are in evidence or liable to inspection in any proceeding under this Ordinance contain any entry in which an informer is named or described, or which might lead to his discovery, the court shall cause that entry to be concealed from view or to be obliterated, but only to the extent that it is necessary to protect the informer from discovery.

(3) If, in a trial for any offence against this Ordinance or any rule made thereunder, the court, after full inquiry, believes that the informer wilfully made in his complaint a material statement which he knew or believed to be false or did not believe to be true or, if the court is of the opinion that justice cannot be done without the discovery of the informer, it shall be lawful for the court to require the production of the original complaint, if in writing, and permit inquiry and require full disclosure concerning the informer.

Protection of informers from discovery.

54. (1) Where, in any proceedings under this Ordinance, any fine is imposed, the court may award any sum or sums not exceeding one-half the total fine collected to any informer or informers.

(2) For the purpose of this section, informers shall exclude the Controller or any officer appointed under section 3(2).

PART VI

MISCELLANEOUS

Power to make rules and orders.

55. (1) The Majlis Mesyuarat Kerajaan Negeri may make rules generally for carrying out the provisions of this Ordinance, and in particular such rules may provide for -

(a) regulating and controlling the taking, hunting, killing, snaring, trapping or capturing any kind of wild life;

(b) regulating and controlling the transporting of any kind of wild life;

(c) regulating and controlling the keeping of any kind of wild life in captivity, including in private possession, public collections and zoos, farms and ranches;

(d) regulating and controlling the import and export of wild life;

(e) the type of weapons, instruments, contrivances and various other methods which may be used in the taking, shooting or killing of wild life;

(f) regulating the activities which can be done for research and other scientific or other purposes inside Wild Life Sanctuaries;

(g) prescribing the powers, duties, responsibilities and other activities of Honorary Wild Life Rangers and a Special Wild Life Committee;

(h) granting exemption from anything provided by such rules;

(i) provisions for appeal against or review of the exercise of any discretion vested by the rules in any Wild Life Officer;

(j) regulating and controlling the collection, sale, offer for sale, export or import of turtle eggs, edible birds' nests, guano or animal faeces;

(k) incentives, by way of grants or other forms of monetary rewards, to any person or body of persons involved in the supervision, control and management of a Wild Life Sanctuary and the protection of wild life therein or to any person who provides information leading to the conviction of any person of any offence under this Ordinance;

(l) the fees and forms for licences and permits issued or granted under this Ordinance;

(m) procedures and forms for compounding of offences; and

(n) anything which requires to be prescribed or provided for under this Ordinance.

(2) The Minister may, by order published in the Gazette, amend any of the Schedules.

Repeal and saving.

56. (1) The Wild Life Protection Ordinance, 1990 is hereby repealed. Ord. No. 1/90.

(2) Any wild life sanctuary constituted or deemed to have been constituted under the repealed Ordinance shall, if still subsisting or in force at the commencement of this Ordinance, be deemed to be a wild life sanctuary constituted under Part III of this Ordinance, until or unless amended or revoked under and by virtue of this Ordinance, and the provisions of this Ordinance shall apply thereto:

Provided that where a forest reserve or a protected forest or any part thereof has been constituted as a wild life sanctuary under Part II of the repealed Ordinance, the Minister having responsibilities for forestry shall, in pursuance of sections 24 or 39 of the Forests Ordinance, take such action as is necessary, for that forest reserve or protected forest or any part thereof to cease to be a forest reserve or protected forest, as the case may be.

(3) Any rule, order or direction, notice or notification made, issued or given before the commencement of this Ordinance, under the repealed Ordinance shall, if it could have been made, issued or given under any corresponding provision of this Ordinance, continue in force, and have the like effect, as if it had been so made, issued or given, as the case may be.

(4) Nothing in this Ordinance shall affect the past operation of, or anything done under, any of the repealed Ordinance provided that any right, privilege, licence or liability existing on the date of commencement of this Ordinance by virtue of the repealed Ordinance, shall be subject to this Ordinance.

(5) Any action, suit or proceeding which has been instituted, filed or commenced under the repealed Ordinance and is still pending on the date of commencement of this Ordinance shall be continued under the provisions of the repealed Ordinance until its final conclusion as if this Ordinance has not been enacted.

FIRST SCHEDULE

(Section 2(1))

PART I

TOTALLY PROTECTED ANIMALS

English name	Scientific name	Local name
A. MAMMALS		
Slow loris	*Nycticebus coucang*	Ukang; Bengkang (I)
Western tarsier	*Tarsius bancanus*	Kera hantu; Ingkat (I)
Silvered langur	Presbytis cristata	Lotong
Hose's langur	*Presbytis hosei*	Berangad
White-fronted langur	*Presbytis frontata*	Puan
Banded langur	*Presbytis melalophos*	Penetat
Maroon langur	*Presbytis rubicunda*	Lotong merah; jelu merah (I)
Proboscis monkey	*Nasalis larvatus*	Orang belanda; rasong (I)
Borneon gibbon	*Hylobates muelleri*	Wak-wak; empeliau (I)
Orang-utan	*Pongo pygmaeus*	Mawas; maias (I)
Giant squirrel	*Ratufa affinis*	Tupai kerawak
Tufted ground squirrel	*Rheithrosciurus mactoris*	Tupai
Clouded leopard	*Neofelis nebulosa*	Rimau dahan; engkuli (I)
Bay cat	*Felis badia*	Kucing merah
Marbled cat	*Felis marmorata*	Kucing dahan
Flat-headed cat	*Felis planiceps*	Kucing hutan
All whales, dolphins and porpoises	*All species of Cetacea*	Paus; lumba lumbi
Dugong	*Dugong dugon*	Dugong; duyong (I)
Rhinoceros	*Dicerorhinus sumatrensis*	Badak
Wild cattle	*Bos javanicus*	Tembadau
Naked bat	*Cheiromeles torquatus*	
B. BIRDS		
Oriental darter	*Anhinga melanogaster*	
Pacific reef egret	*Egretta sacra*	Ujoh laut
Cattle egret	*Bubulcus ibis*	Burung apuh; burung lima ringgit
Storm's stork	*Ciconia stormi*	Bangau
Lesser adjutant stork	*Leptoptilos javanicus*	Bangau
White-bellied fish eagle	*Haliaeetus leucogaster*	Lang laut
Grey-headed fish eagle	*Ichthyophaga ichthyaetus*	Lang laut
Bornean peacock pheasant	*Polyplectron schleiermacheri*	Ruai
Argus pheasant	*Argusianus argus*	Ruai
Bulwer's pheasant	*Lophura bulweri*	Bekia
Black-naped tern	*Sterna sumatrana*	Burung laut
Bridled/brown-winged tern (I)	*Sterna anaethetus*	Burung laut; Entala puteh
All phalaropes	*Phalaropus spp.*	Kedidi
All imperial pigeons	*Ducula spp.*	Rawa
Mountain imperial pigeon	*Ducula badia*	Rawa
Silvery (grey) wood pigeon	*Columbia argentina*	Pergam
White-crowned hornbill	*Aceros comatus*	Sentuku (I)

Bushy-crested hornbill	*Anorrhinus galeritus*	Kakalau (I)
Wrinkled hornbill	*Aceros corrugatus*	Alau buloh
Wreathed hornbill	*Aceros undulatus*	Alau sangoh
Asian black hornbill	*Anthracoceros malayanus*	Alau babi; Gagak/rengak (I)
Oriental pied hornbill	*Anthracoceros albirostris*	Alau pedada; bruie (I)
Rhinoceros hornbill	*Buceros rhinoceros*	Kenyalang (I)
Helmeted hornbill	*Buceros vigil*	Tajai (I)
All pittas	*Pitta spp.*	Burung pacat
Straw-headed bulbul	*Pycnonotus zeylanicus*	Barau-barau
Bornean bristlehead	*Pityriasis gymnocephala*	
Sun bear	*Helarctos malayanus*	Beruang

C. REPTILES

All marine turtles	All species of *Chelonidae* and *Dermochelyidae*	Penyu-penyu laut
Painted terrapin	*Callugur borneensis*	Beluku
Terrapin	*Orlitia borneensis*	Beluku
Niah cave gecko	*Cyrtodactylus cavernicolus*	Cicak gua Niah
Earless monitor lizard	*Lanthanotus borneensis*	Cicak purba

PART II

PROTECTED ANIMALS

English name	Scientific name	Local name
A.MAMMALS		
All treeshrews	All species of Tupaiidae	
All bats	All species of Chiroptera	
All primates	All species of Primates excluding those already listed in Part I	
Flying lemur/colugo	*Cynocephalus variegatus*	Kubung
Pangolin	*Manis javanica*	Tenggiling
All flying squirrels	All species of Petuaristinae	Tupai terbang
Porcupines	All species of Hystricidae	Landak
Bear cat	*Arctitis binturong*	Bintutung
All civets and mongooses	All species of Viverridae	Musang
All otters	All species of *Lutra* and *Aonyx*	Memerang
All cats	All species of Felidae excluding those already listed in Part I	Kucing hutan
B.BIRDS		
Christmas frigatebird	*Fregata andrewsi*	
All herons, egrets and bitterns, excluding those already listed in Part I	All species of Ardeidae	
All storks, excluding those already listed in Part I	All species of Ciconiidae	
Osprey	*Pandion haliaetus*	Lang; meaul
All falcons	All species of Falconidae	Rajawali; menaul
All scrubfowl, partridges and pheasants, excluding those already listed in Part I	All species of Phasianidae	
All waders, exluding those already listed in Part I	All species of Charadiiformes	
Metallic pigeon	*Columbia vitiensis*	Pergam
Nicobar pigeon	*Caloenas nicobarica*	Pergam
All owls	All species of Tytonidae and Strigidae	Burung hantu
All swiftlets	All species of *Aerodramus*, *Hydrochous* and *Collocalia*	Burung layang
All kingfishers	All species of Alcedinidae	Pekaka
All woodpeckers	All species of Picidae	Belatok
Asian paradise flycatcher	*Terpsiphone paradisi*	Burung sambar ekor panjang
Grackle or hill myna	*Gracula religiosa*	Burung tiong
All parrots and parakeets	All species of Psittacidae	Bayan
White-rumped shama	*Copyschus malabaricus*	
C. REPTILES		
Burmese brown tortoise	Geochelone emys	Baning
All soft-shelled turtules	All species of Tryonychidea	Labi-labi
False gharial	*Tomistoma schlegli*	Buaya jujulong

Estuarine crocodile	*Crocodylus porosus*	Buaya katak
All monitor lizards	All species of Varanus	Biawak
King cobra	*Ophiophagus hannah*	Ular tedung
Common cobra	*Naja naja*	Ular tedung
All pythons	*All species of Python*	Ular sawah
D. FISH		
Arowana (dragonfish)	All species of Osteoglossidae	Ikan seruk; ikan siluk
E. INVERTEBRATES		
All hard and soft corals	All species of Hydrozoa and Anthozoa (Actinozoa)	Batu karang
Raja Brooke's birdwing	*Troides brookiana*	

F.ADDITIONAL SPECIES

All species of animals listed in Appendces I and II of the Convention on Endangered Species of Wild Flora and Fauna (CITES), excluding those already listed in Part I

PART III

(Section 29)

ANIMALS WHICH MAY BE IMPORTED OR EXPORTED UNDER LICENCE

All animals, other than totally protected animals.

SECOND SCHEDULE

(Section 2(1))

PART I
TOTALLY PROTECTED PLANTS

Scientifc name	Common name
1. All *Rafflesia* species	Bunga pakma
2. *Dipterocarpus obloglofolius*	Ensurai

PART II
PROTECTED PLANTS

1. *Shorea macrophylla*	Engkabang jantong
2. *Shorea splendida*	Engkabang bintang
3. *Shorea helmsleyana*	Engkabang gading
4. *Shorea simins*	Engkabang terendak
5. *Shorea palembanica*	Engkabang asu
6. *Shorea stenoptera*	Engkabang rusa
7. *Shorea pinanga*	Engkabang langai bukit
8. *Shorea ochracea*	Raru
9. All Ficus species	Pokok ara
10. *Sonneratia alba*	Perepat
11. *Sonneratia caseolaris*	Pedada
12. *Avincennia alba*	Api-api hitam
13. *Avincennia lanata*	Api-api
14. *Avicennia marina*	Api-api merah
15. *Avicennia officinalis*	Api-api sudu
16. *Lumnizera littorea*	Terentum merah
17. *Koompassia excelsa*	Tapang
18. *Koompassia malaccensis*	Menggris
19. *Aetoxylon sympetalum*	Kayu gahru
20. *Aquilaria beccariana*	Kayu gahru, engkaras (I)
21. *Aquilaria malaccensis*	Kayu gahru
22. *Aquilaria microcarpa*	Kayu gahru
23. *Didesmandra aspera*	
24. *Casuarina equisetifolia*	Rhu laut
25. All *Rhodedendron* species	
26. All *Nepenthes* species	Periok kera
27. All Orchidaceae species	All orchids
28. *Salacca magnifica*	

29.	*Johannesteysmannia altifrons*	Ekor buaya
30.	*Areca borneensis*	Pinang
31.	*Areca jugahpunya*	Pinang
32.	*Pinanga mirabilis*	Pinang
33.	*Pichisermollia subcaulis*	Pinang
34.	*Licaula orbicularis*	Biris
35.	*Eurycoma longifolia*	Tongkat ali, sengkayap
36.	*Goniothalamus velutinus*	Kayu hujan panas
37.	All *Monophyllaea* species	
38.	*Antiaris toxicaria*	Ipoh
39.	All peat swamp species of *Madhuca*	Ketiau
40.	*Calophyllum lanigerum*	Bintangor
41.	*Calophyllum teysmanii*	Bintangor
42.	*Cycas rumphii*	Paku gajah, paku laut
43.	All epiphytic *Lycopodium* species	Ekor tupai
44.	All *Begonia* species	Riang, telingar gajah
45.	All *Aeschynanthus* species	
46.	All *Cyrtandra, Didymorcarpus* and species	Melebab

47. All species of plant listed in Appendcies I and II of the Convention on Endangered Species of Wild Flora and Fauna (CITES), excluding those already listed in Part I.

PART III
(Section 30)

PLANTS WHICH MAY BE IMPORTED OR EXPORTED UNDER LICENCE

All plants, other than totally protected plants.

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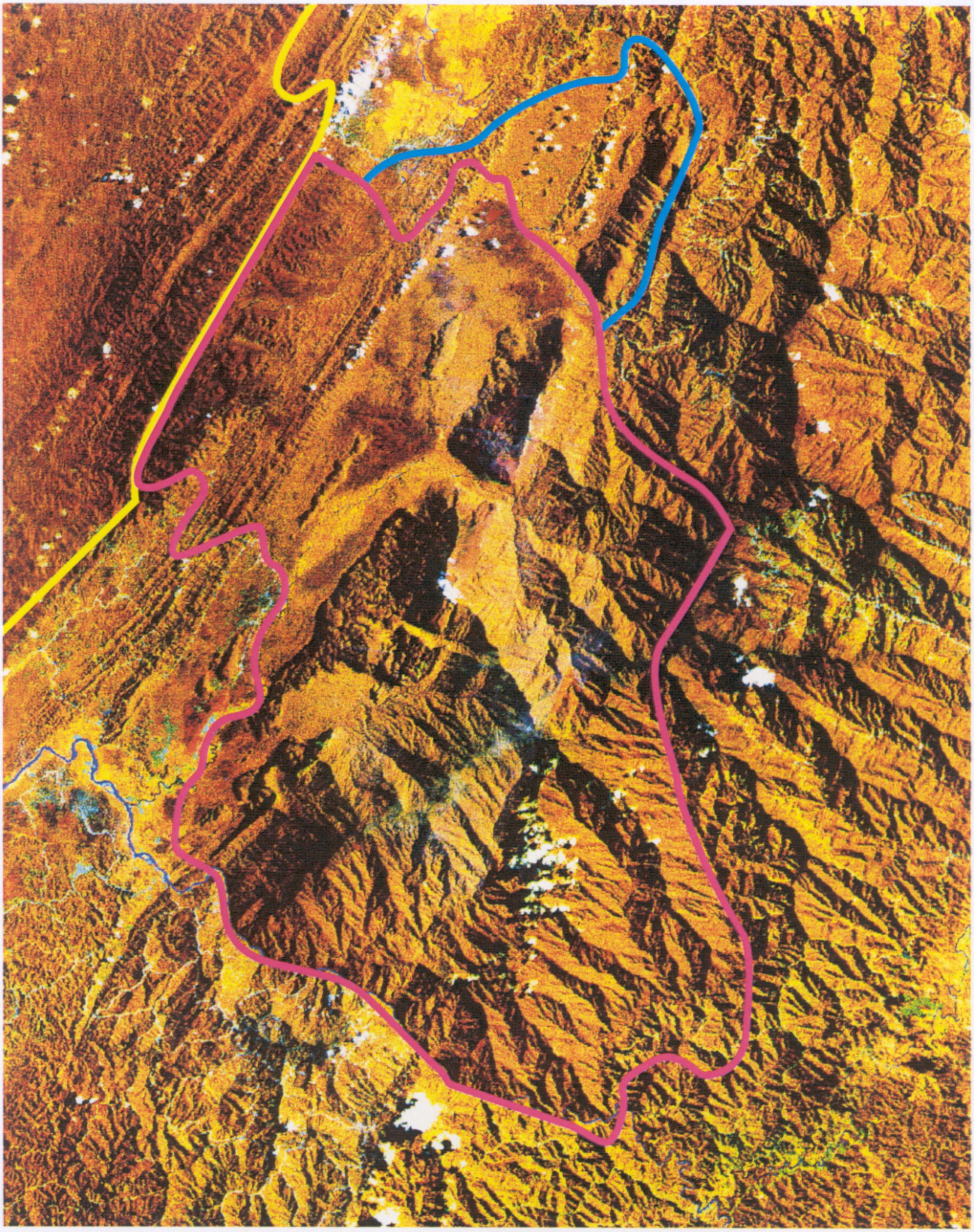
MULU NATIONAL PARK



Forest Department

PARK BOUNDARY
INTERNATIONAL BOUNDARY
BUDA NATIONAL PARK BOUNDARY

Data Source : Landsat TM Bands 4,5,3,
Projection : RSO/Everest (Sabah & Sarawak)
Processed by : GIS Unit Forest Dept. Kuching, Sarawak.

Figure 1. South East Asia (Map)

Northern Sarawak.

FIGURE 2: THE BOUNDARY AND RELIEF.

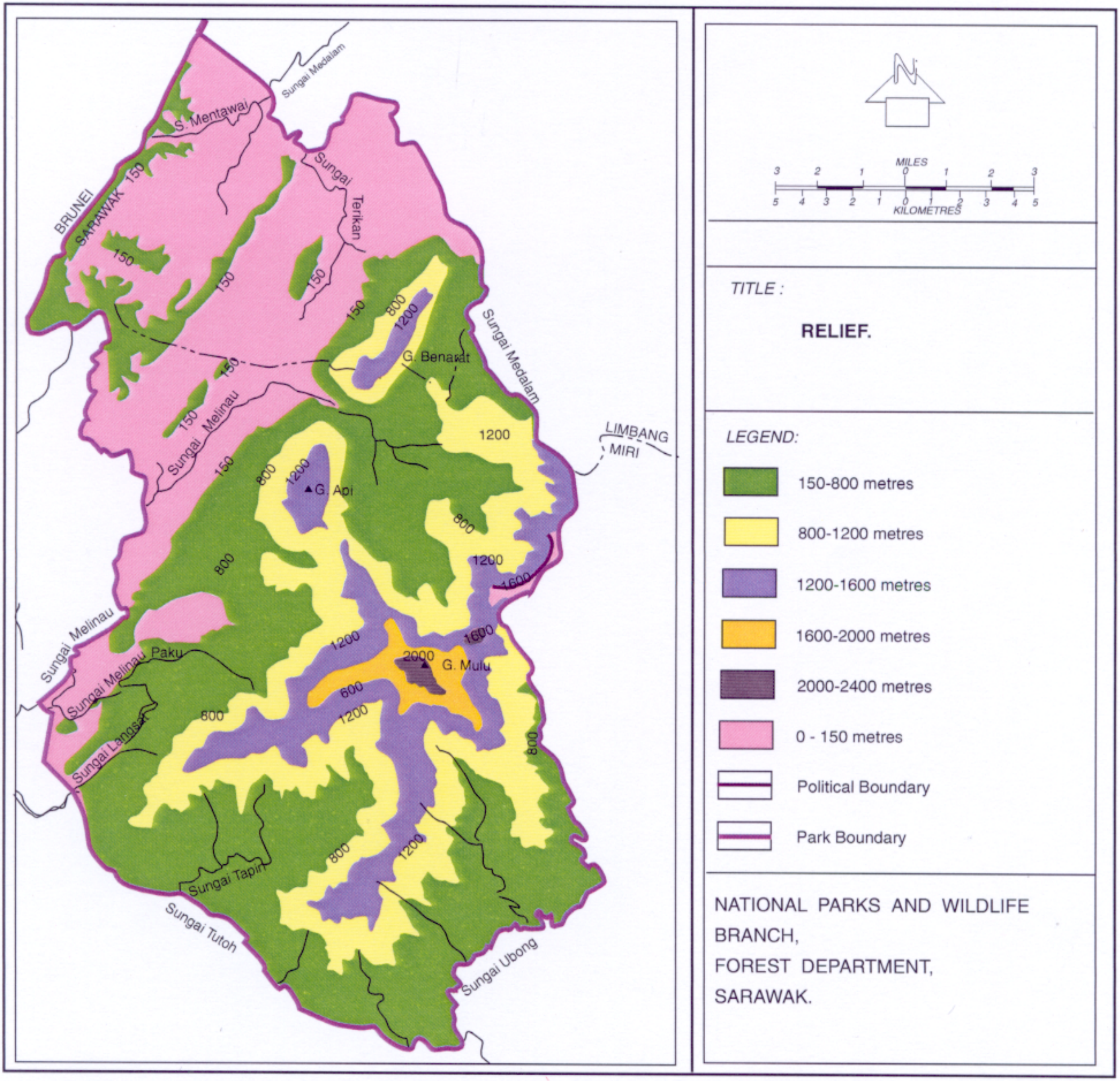


FIGURE 3: PROPOSED EXTENSIONS.

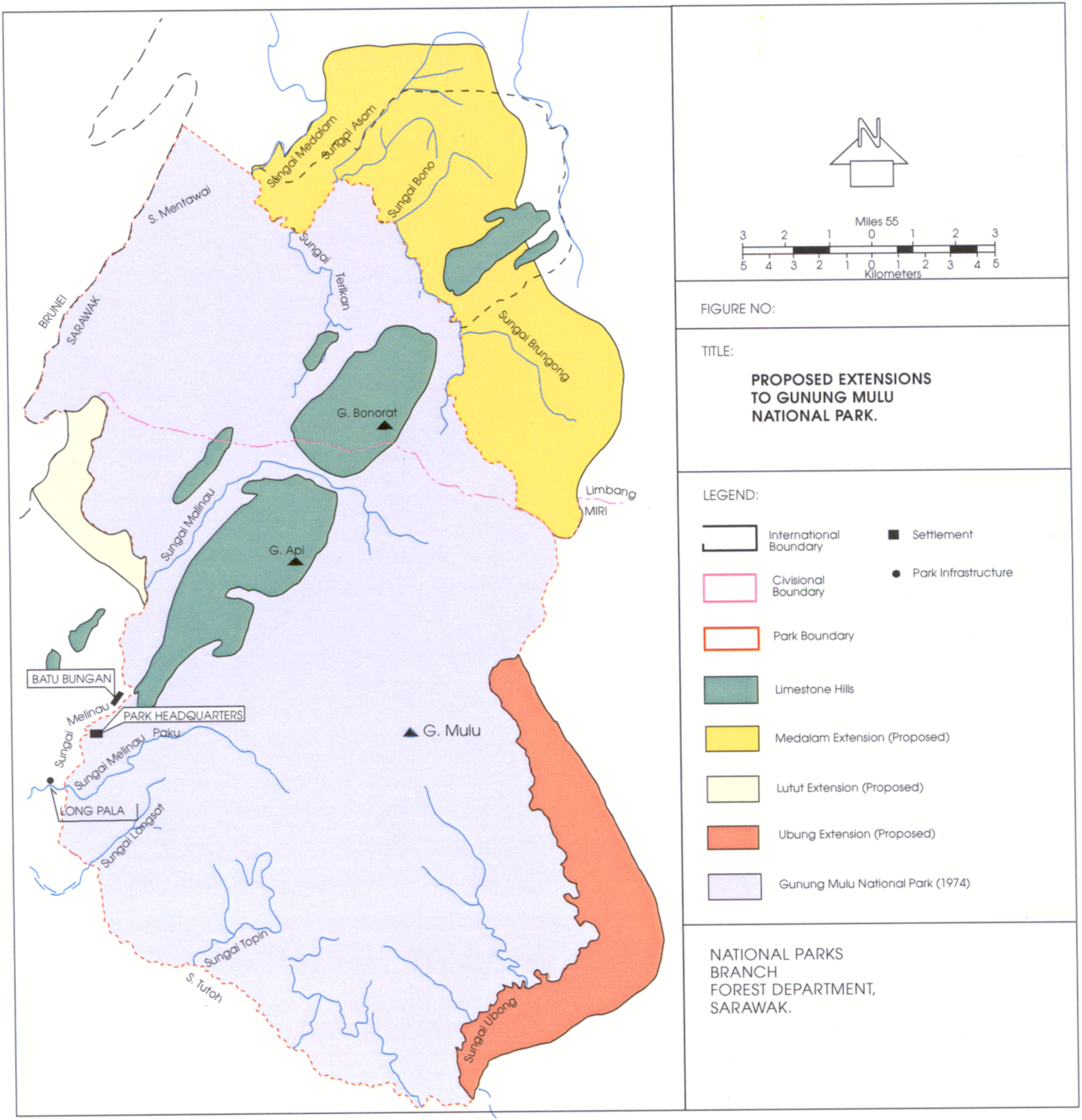


FIGURE 4: THE VEGETATION.

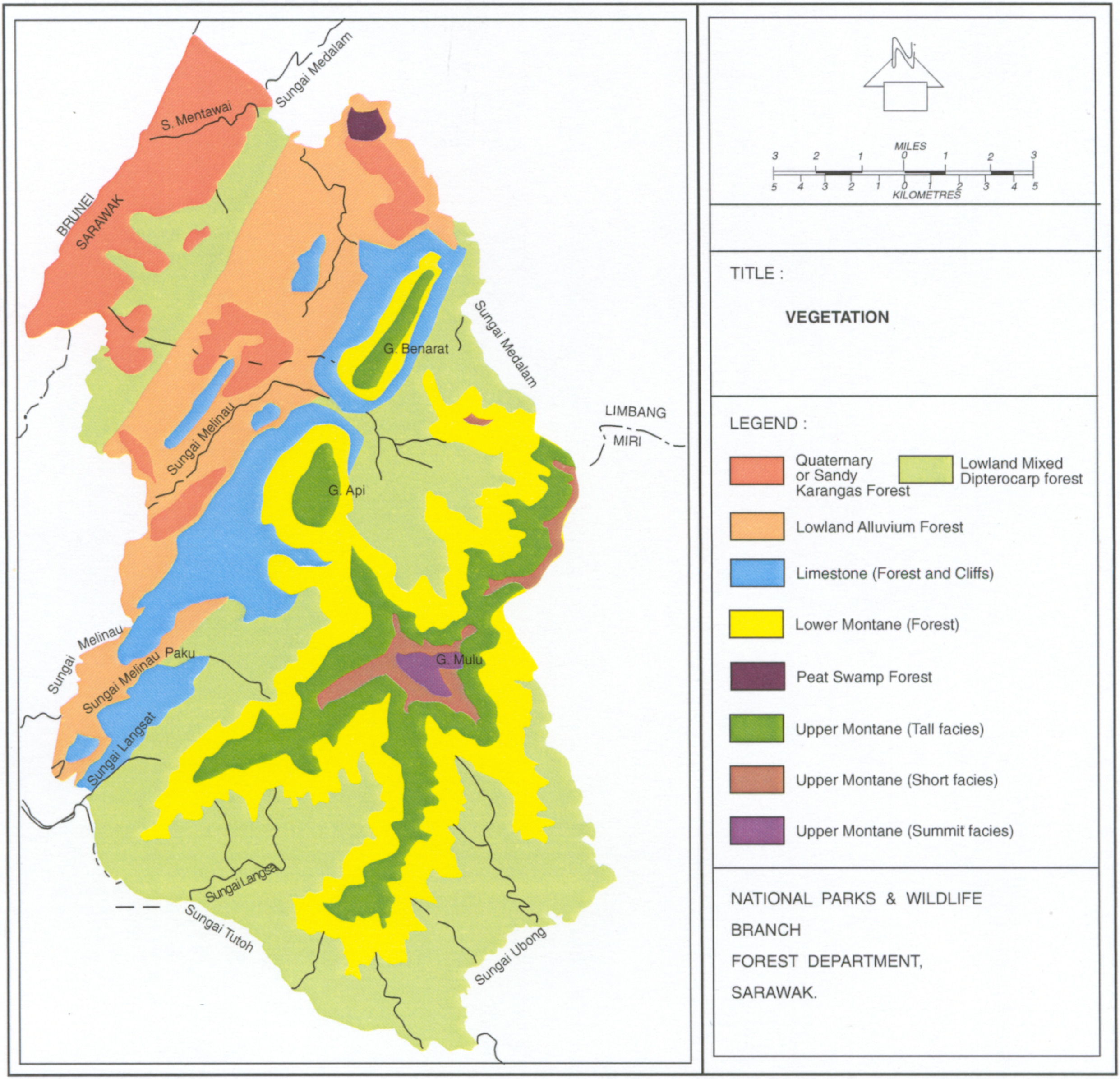
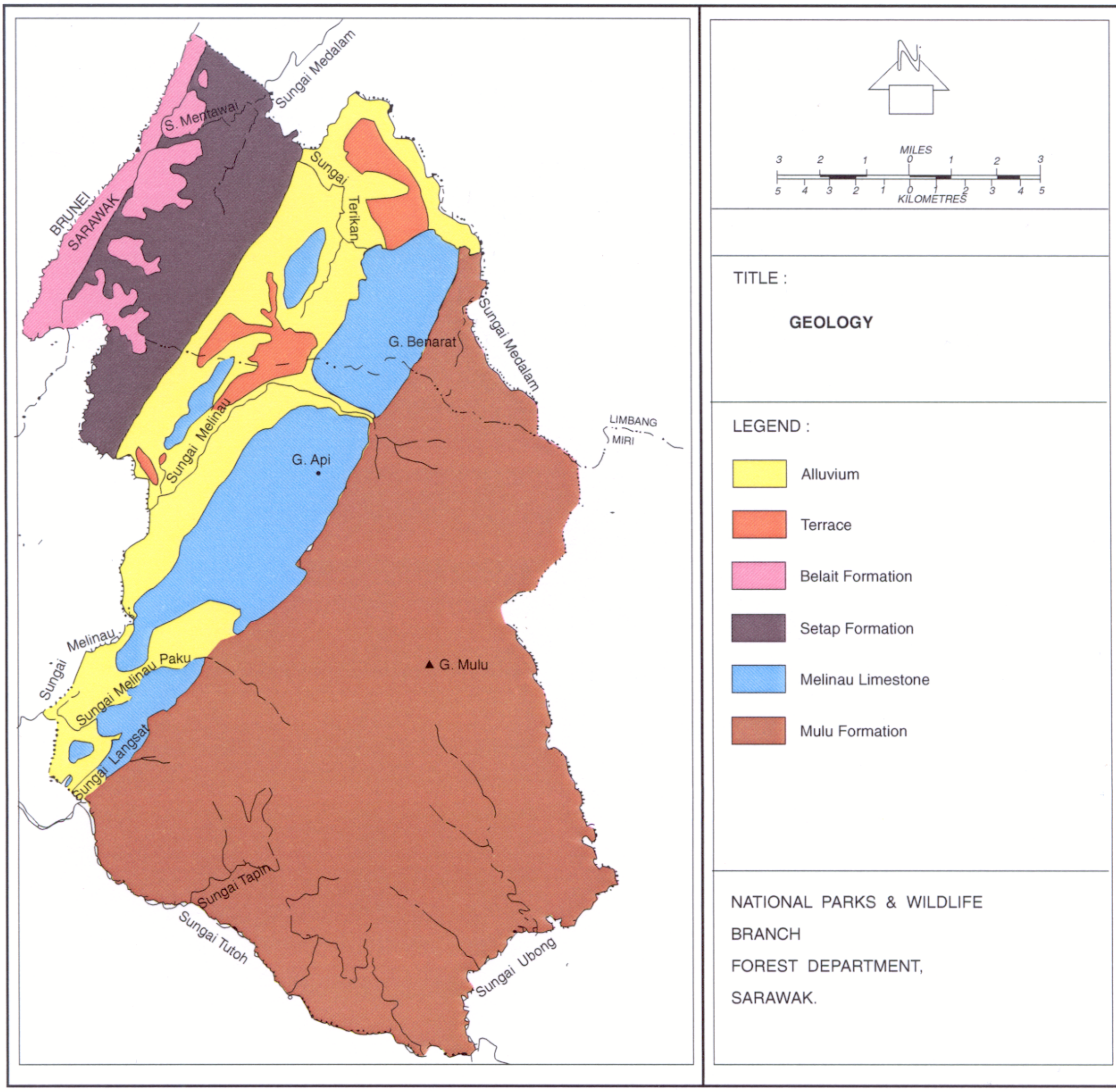
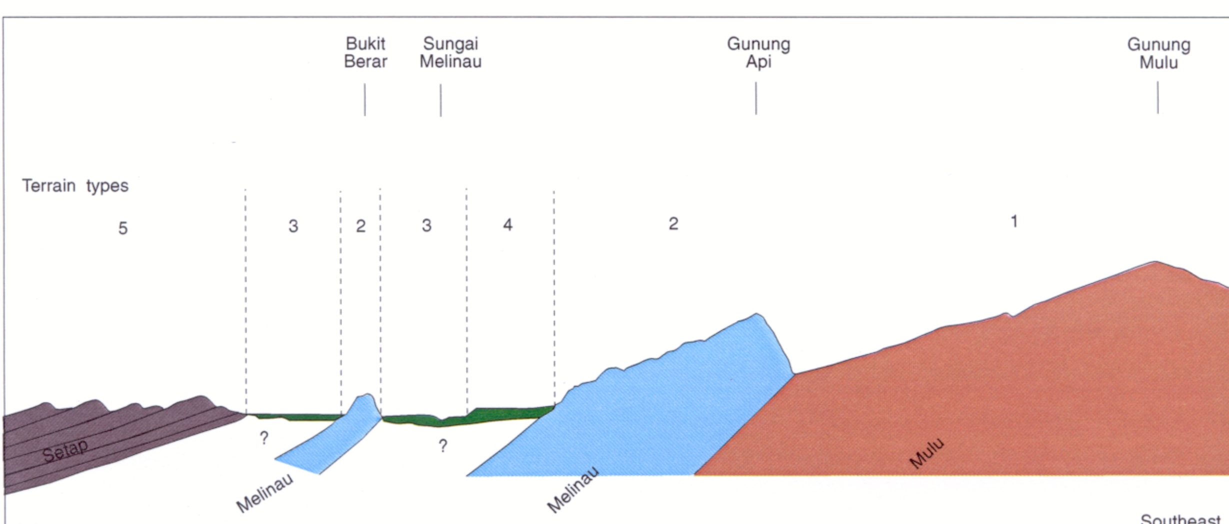


FIGURE 5: THE GEOLOGY.





Diagrammatic cross section through the major terrain and land-form types of Gunung Mulu National Park.

FIGURE 6: THE CAVES OF THE GUNUNG MULU NATIONAL PARK.

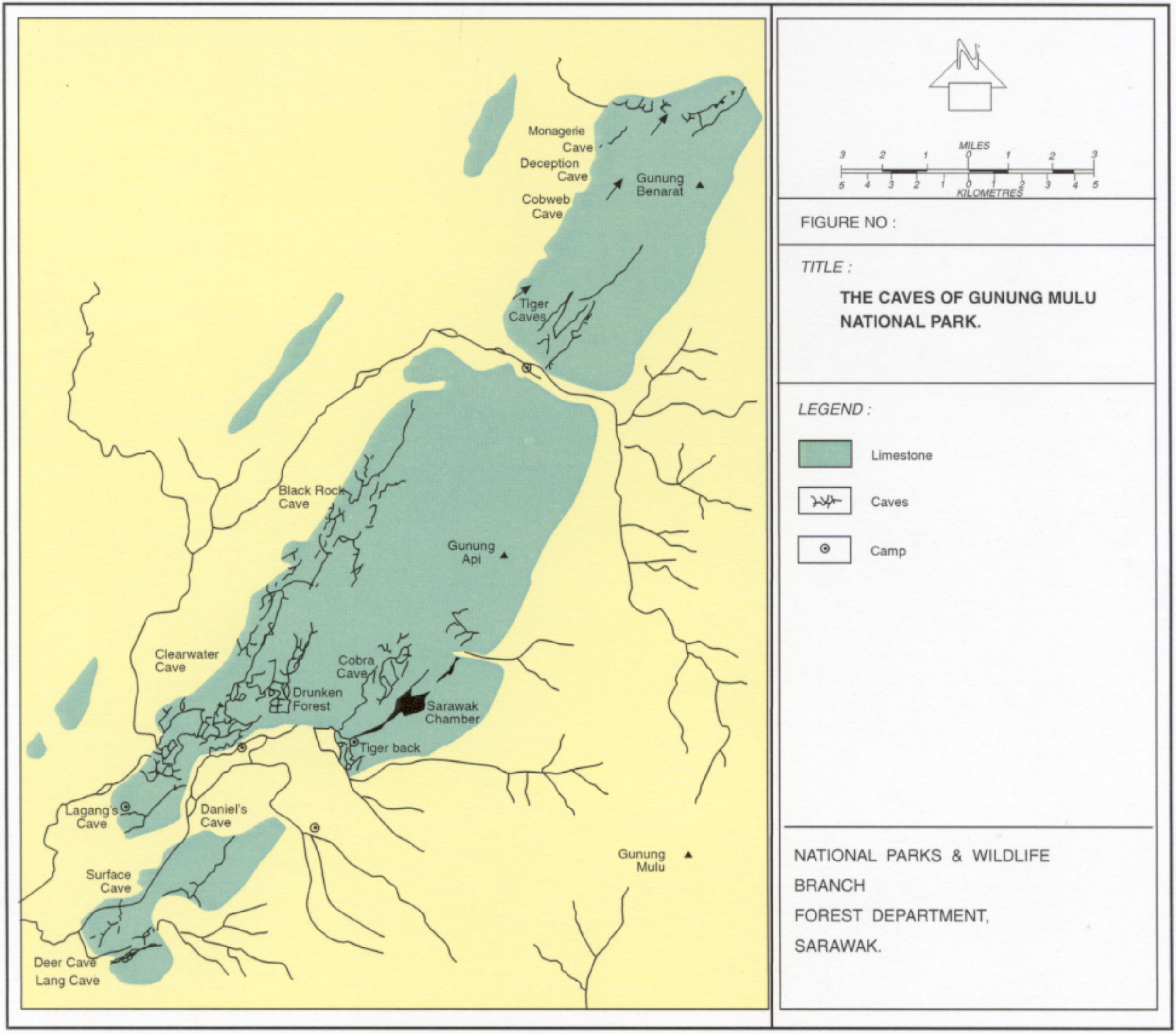
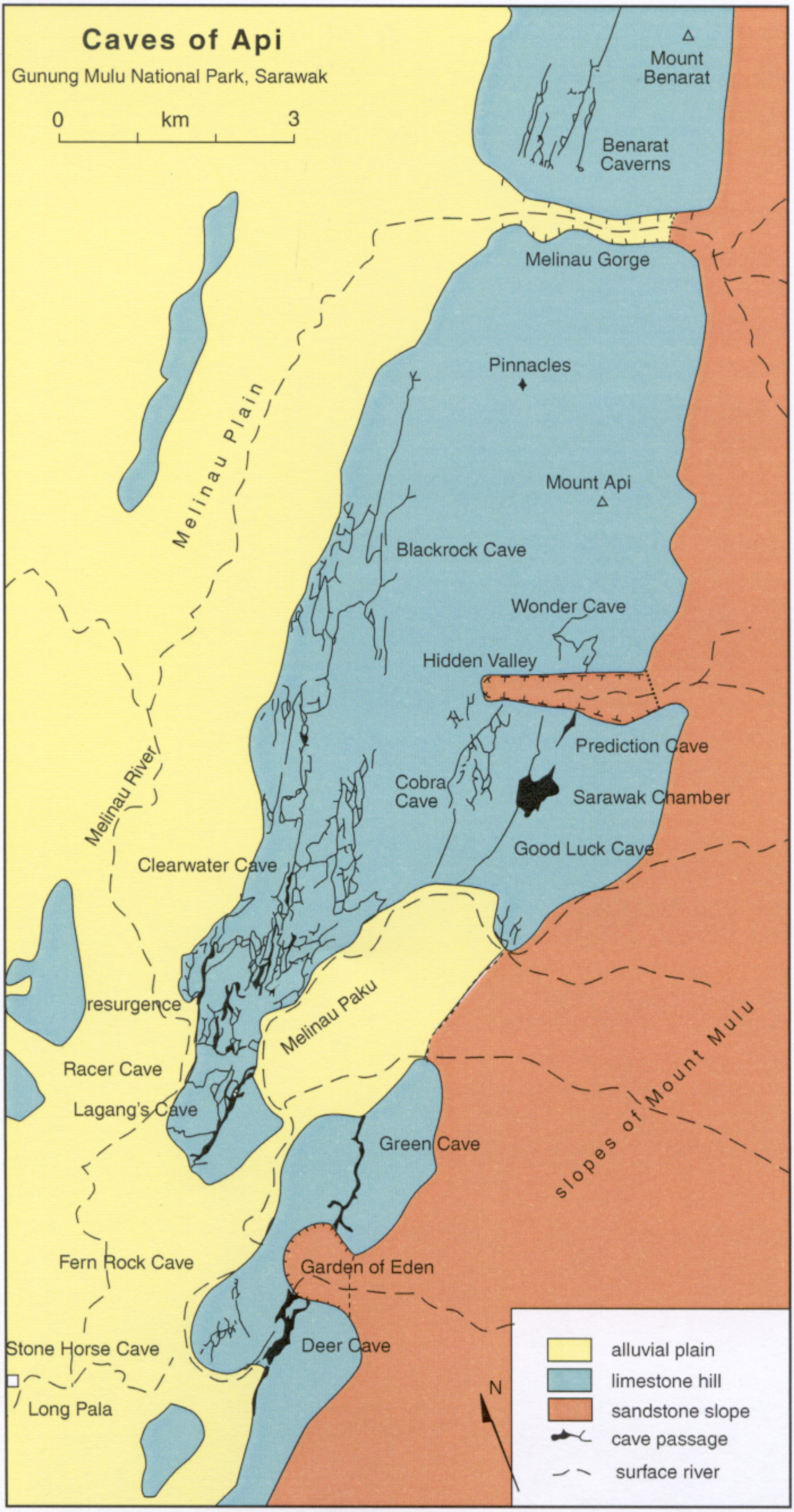


FIGURE 7: THE CAVES OF THE SOUTHERN HILLS AND GUNUNG API



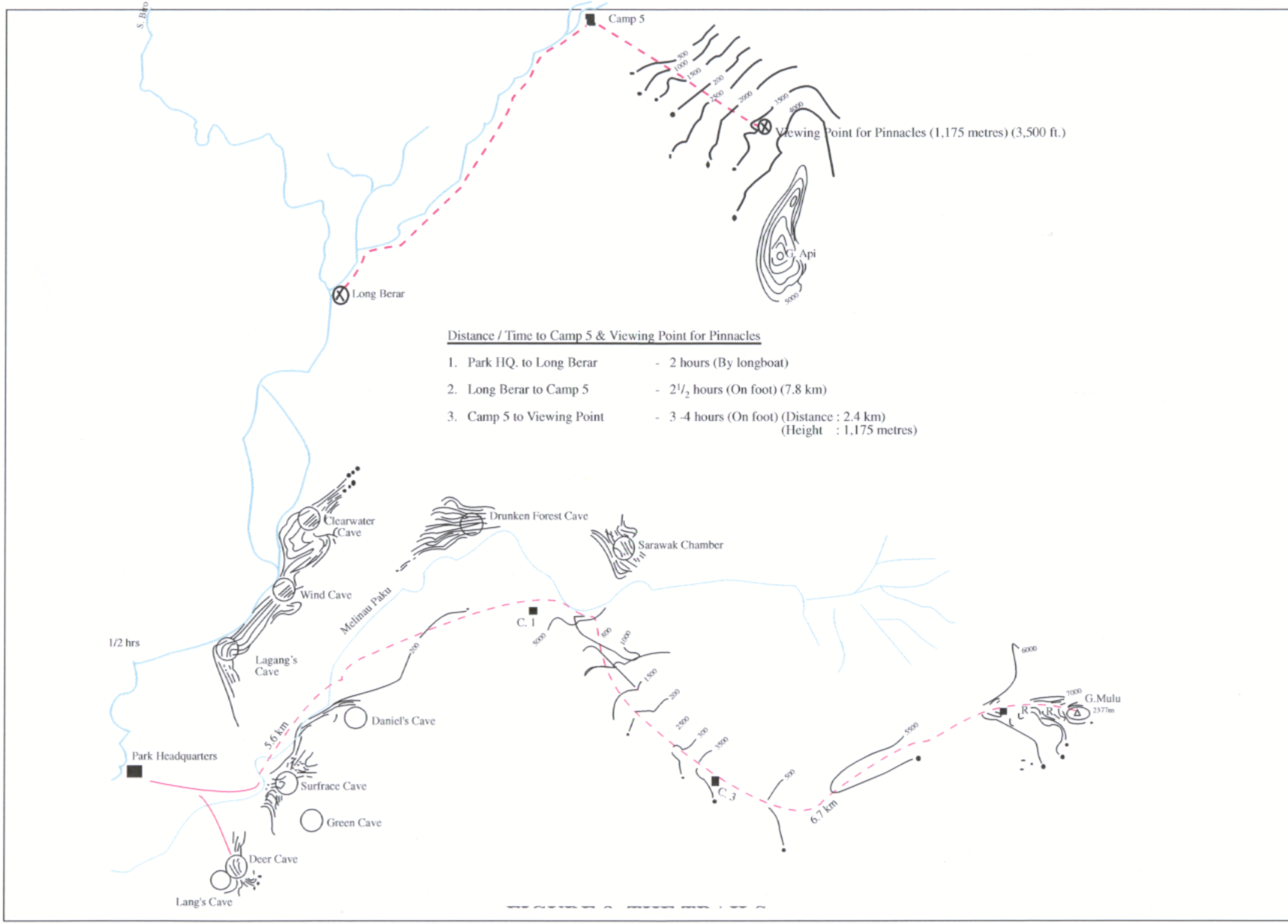


FIGURE 8: THE TRAILS.

FIGURE 9: THE HEAD HUNTERS TRAIL AND THE CAVES OF BUKIT TERIKAN.

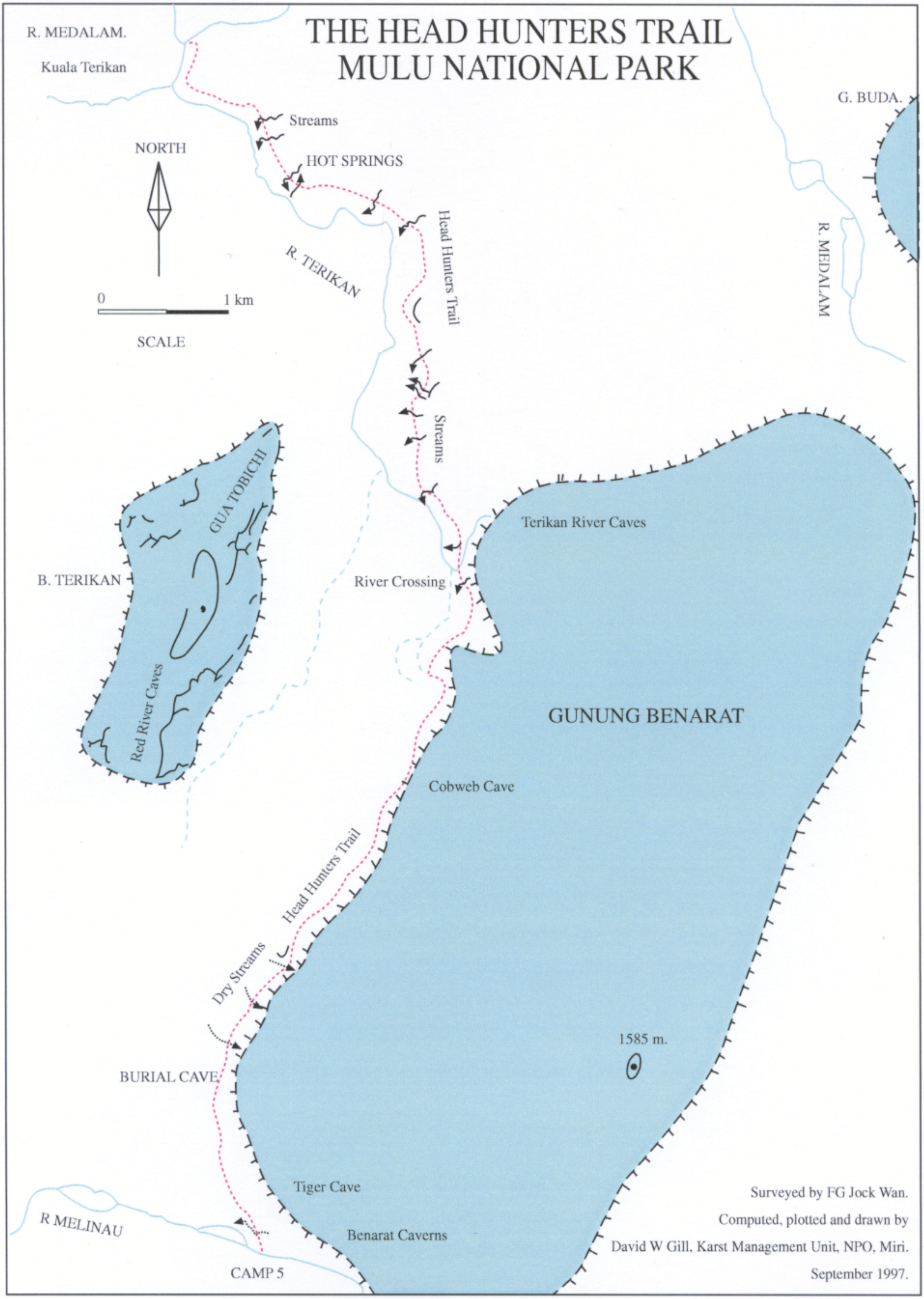


FIGURE 10: ZONES

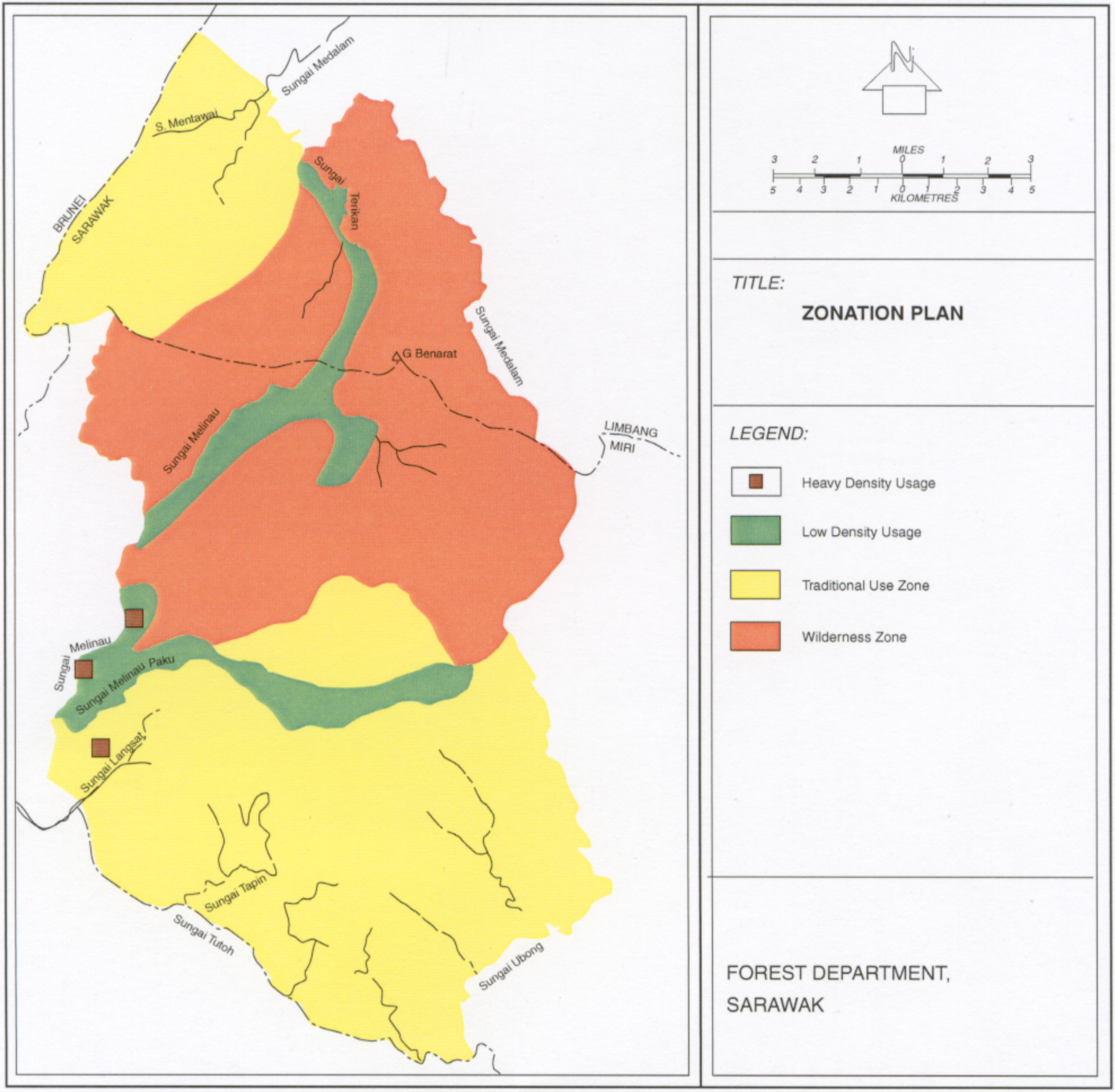
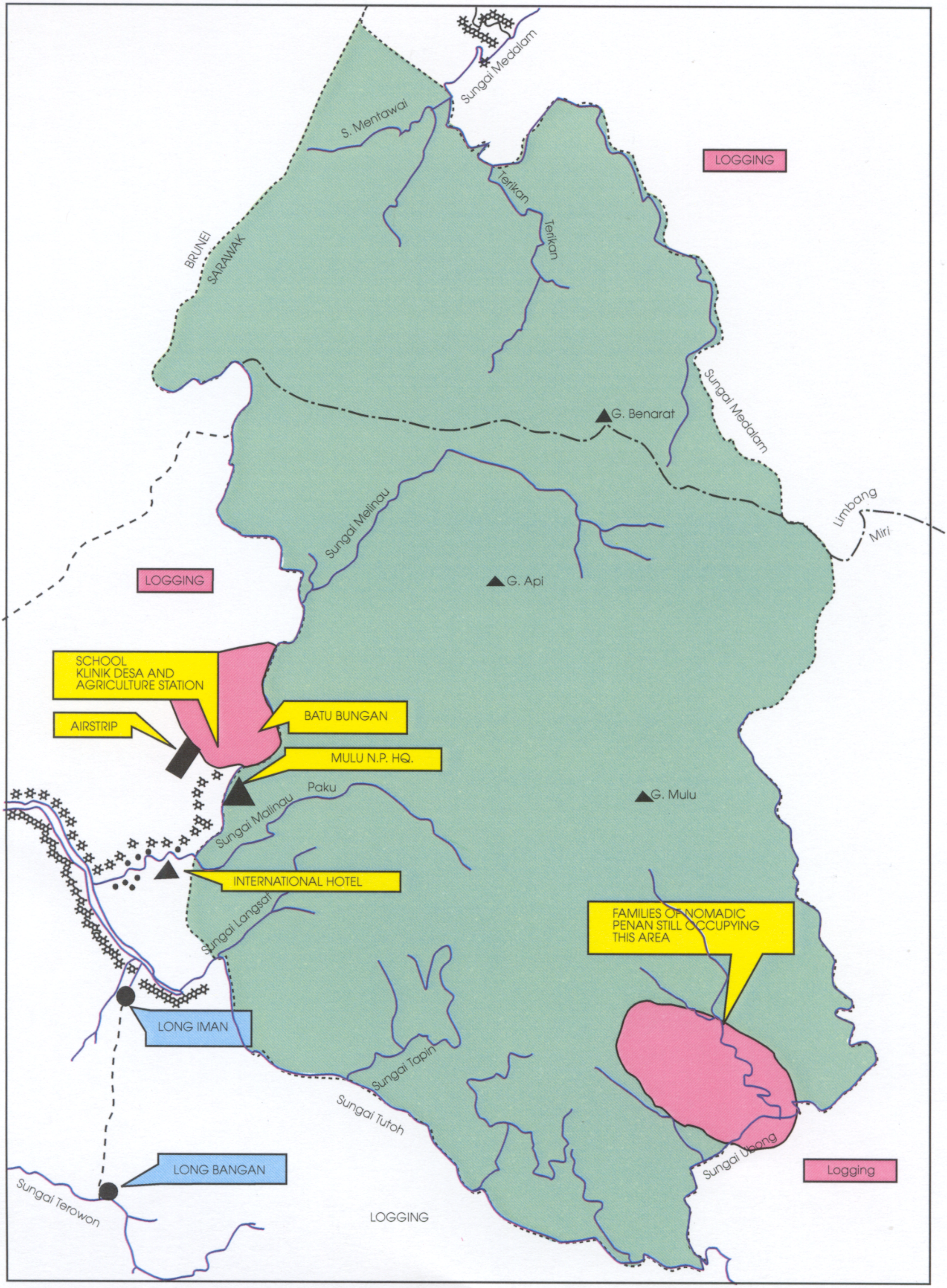
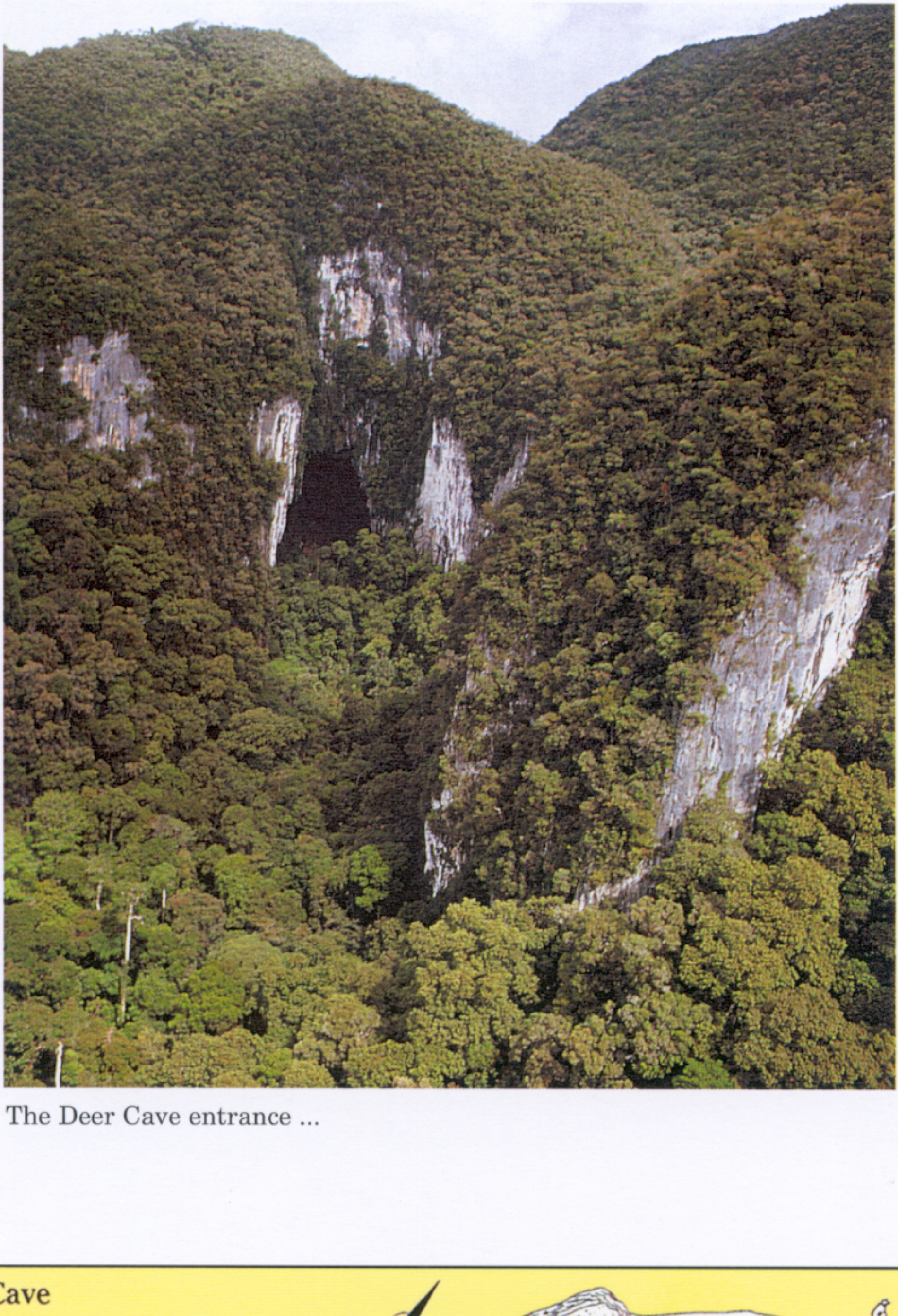
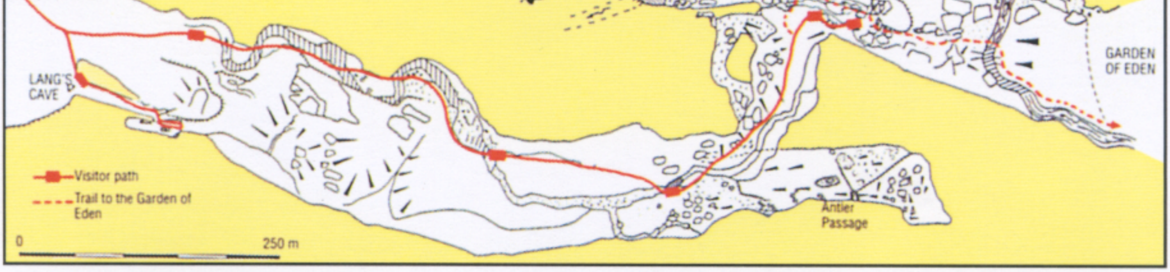


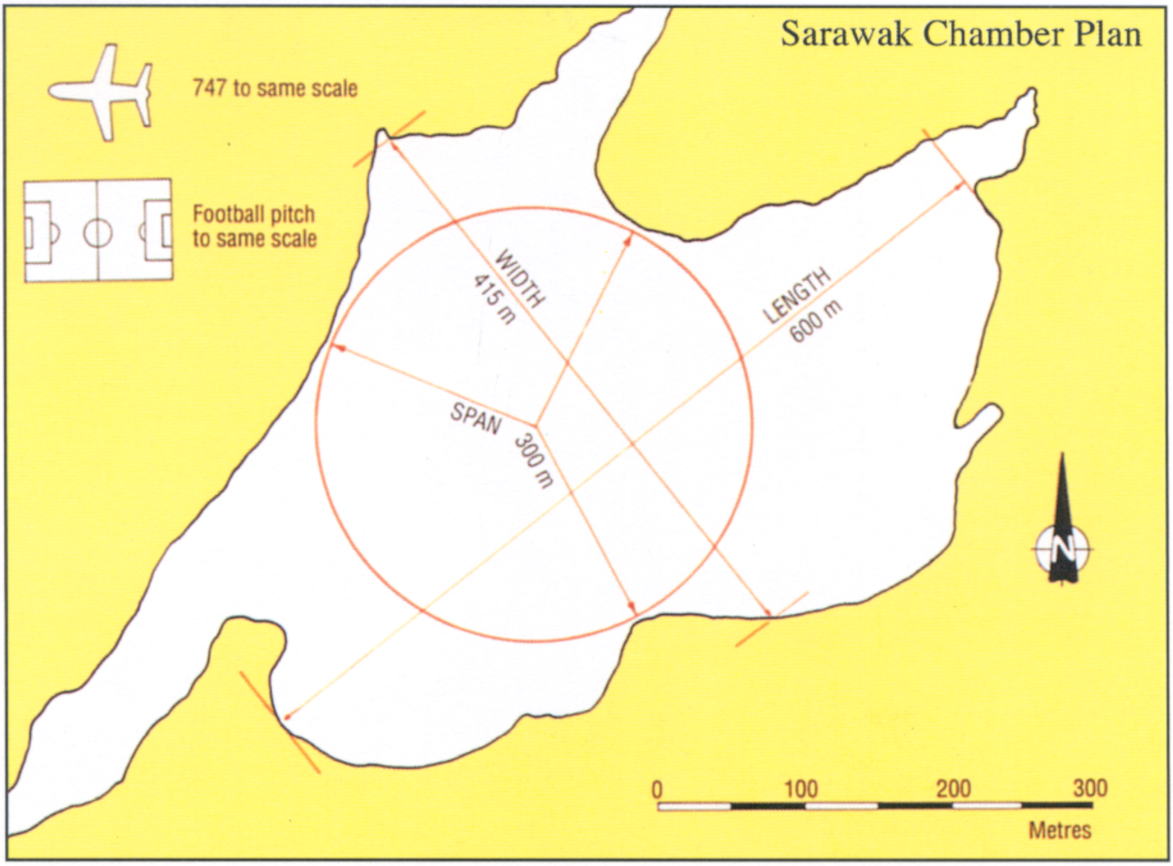
FIGURE 11: SETTLEMENT.



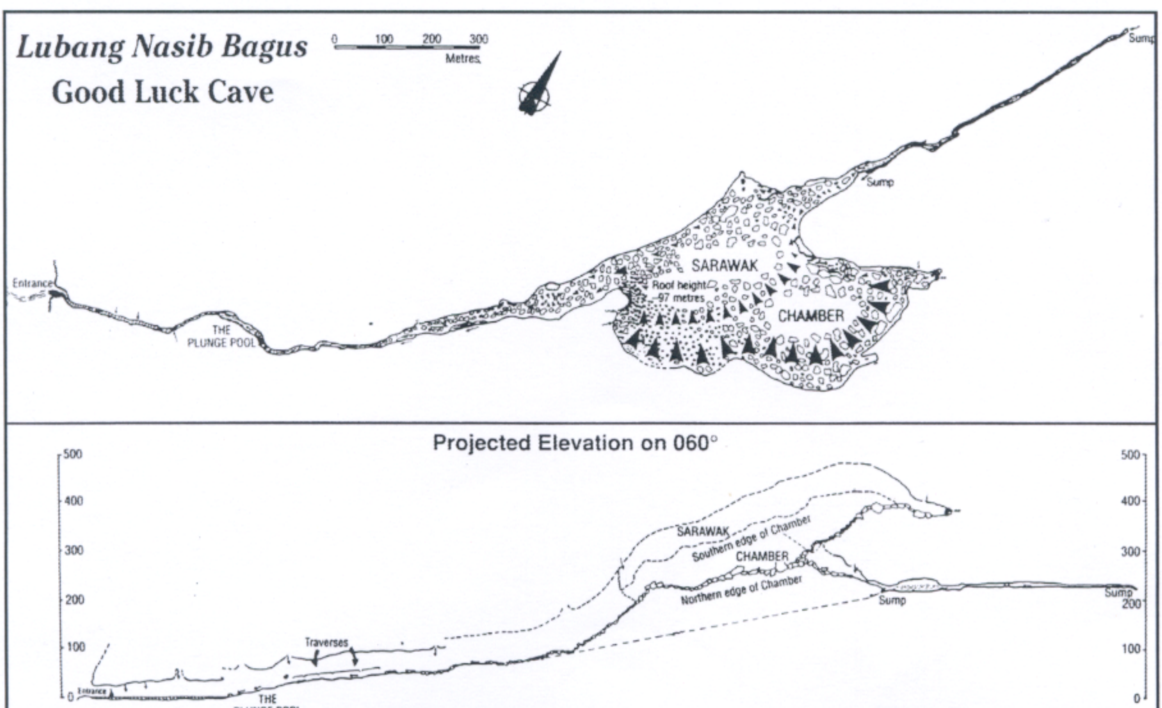


The Deer Cave entrance ...





Sarawak Chamber Plan
747 to same scale
Football pitch to same scale
WIDTH 415 m
LENGTH 600 m
SPAN 300 m
N
0 100 200 300
Metres



Lubang Nasib Bagus
Good Luck Cave
0 100 200 300
Metres
Sump
Sump
Entrance
THE PLUNGE POOL
SARAWAK
Roof height 97 metres
CHAMBER
Projected Elevation on 060°
500
400
300
200
100
0
SARAWAK
Southern edge of Chamber
CHAMBER
Northern edge of Chamber
Sump
Sump
Traverses
Entrance
THE PLUNGE POOL

The Melinau Paku Valley looking towards the alluvial plain.

Hidden Valley, Gunung Api Karst.

The Clearwater river passage showing the well defined "notch".

Clearwater III River.

GUNUNG MULU NATIONAL PARK

A MANAGEMENT AND DEVELOPMENT PLAN

prepared by

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and

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The views expressed in this document do not necessarily
reflect the policies of IUCN or WWF

Royal Geographical Society
London

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The photograph on the cover is Gunung Benarat
taken from the north slopes of Gunung Api
by A. R. Hanbury-Tenison

*****

Grateful acknowledgement is made to the following who helped to prepare this report for the press

Gianna Fargnoli, Ted Hatch, Kathryn Kavanagh, Alison Paul
Shane Wesley-Smith and especially to Loveday Hosking who
typed the text

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P R E F A C E

This Management and Development Plan for Gunung Mulu National Park has been produced by the Royal Geographical Society for the Sarawak Government as one of the products of their joint expedition there, from June 1977 to September 1978. During this period over one hundred scientists visited the Park. Their work played a significant part in defining the content of the Park and highlighting the problems of management. It is impossible to mention them all individually but their help is acknowledged here as is the backup logistic support so efficiently given to all scientists by Robin Hanbury-Tenison (Leader and Field Director) and his Deputy, Nigel Winser, and their team.

The Council of the Society sponsored and supported this venture in multidisciplinary field studies. The Sarawak Government cooperated in every way. It appreciated the long-term gains to science of such a survey but was keen to promote the production of this Plan as a positive short-term outcome of the work of the many specialists who visited the Park. A former Deputy Conservator of Forests, Dr J A R Anderson, was engaged to make the basic vegetation survey (with a team from the Sarawak Forest Department) and from his knowledge and experience of the country and its Administration, to prepare the first draft of the Plan. His work was funded by WWF/IUCN (Project 1576).

The final result presented here, which we hope will form the basis of a strategy to develop the Park, is the work of Lord Cranbrook, a zoologist with extensive Malaysian experience and A C Jermy, the Coordinator of the Scientific Programme of the Expedition.

Gunung Mulu National Park has been shown to be one of the richest areas of tropical rain forest so far studied in S E Asia. It is both of national and international importance and we hope that the proposals laid out in this Plan are acceptable as a basis for conservation.

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Gunung Mulu National Park Management and Development Plan

RESUMÉ OF RECOMMENDATIONS

1. Gunung Mulu National Park is 204 sq. miles (52864 ha) of predominantly virgin forest with areas of all the inland forest formations found in Sarawak. It contains a remarkable diversity of land-forms of outstanding beauty and in its limestone hills lie one of the most spectacular regions of the world. It is exceedingly rich in life forms with an estimated 20,000 animal species (the majority of which are insects) possibly 3500 plants (half of which are trees) and over 8000 fungi. A major part of the Plan (Chapter 2) consists of a detailed description.
2. It is agreed that the construction of the Beluru-Limbang Highway (see Chapters 5 and 14) will be an asset to the Park provided that:
   (i) The Director of the Forest Department is fully consulted about the route through the Park.
   (ii) Its construction is controlled to minimise damage to the Park environment
   (iii) The Park regulations are fully respected by all personnel engaged on the project.
   (iv) Strict patrolling of the Highway is maintained.
3. An extension to the Park to incorporate most of the Medalam Protected Forest is considered essential for its satisfactory development. Justification details are given in Chapter 6.
4. The full, long-term objectives of management are laid out in Chapter 7. In order to achieve these the following principal proposals are made (Chapter 8 et sequ.)
   (i) The Forest Department should immediately establish resident staff (Wardens and Park Rangers) in the Park based both at Long Pala and Nanga Mentawai to undertake duties of resource management outlined in Chapter 8 with the necessary administrative proposals in Chapter 13.
   (ii) Buildings are erected at the locations and to the specifications described in Chapter 12. Prefabricated modular units should be used where possible. The Department of Forests should be granted authority to use approved funds and itself to plan and erect all buildings and develop associated facilities proposed in the Plan.

(iii) As soon as possible the assistance of qualified experts should be sought by the Forest Department (if necessary outside Sarawak) to help as follows :

(a) A scientific and technical Assistant to the Warden, with qualifications in Wildlife and Park Management. It is recommended that this post could be filled by an overseas volunteer (para 13.1.3, appendix XXI).

(b) A qualified zoologist to investigate the biology of threatened populations of larger mammals particularly primates (paras 8.4.2.8; 8.5.4.3).

(c) An experienced speleologist to advise on the scientific and tourist potential of the caves. This post could be filled by a specialist(s) from overseas or a consultancy basis until such a time as local expertise is established (para 11.4.3).

(iv) To reopen the Park as soon as possible and to encourage a steady flow of visitors, both from the Baram and the Limbang sides in appropriate proportions. Facilities to be developed are proposed in Chapters 9, 10 and 12.

(v) To offer facilities to self-financed specialists whose scientific interest could be of benefit to the management of the Park (paras 2.7.2.8; 2.9 and 8.4).

1 GENERAL INFORMATION

1.1 Location (See Map 1)

1.1.1 The Gunung Mulu National Park is located in Northern Sarawak, which is a Bornean State in Malaysia, approximately 4°N of the equator and on longitude 114°E. It lies between the headwaters of the Tutuh river, a tributary of the Baram river, within the Fourth administrative Division of Sarawak, and the Medalam river, which is a tributary of the Limbang river within the Fifth Division. It thus spans the boundary, formed by a watershed, between the two administrative Divisions, though more than two-thirds of the area of the Park falls within the Fourth Division. The north-eastern boundary of the Park lies along the international boundary with the State of Brunei.

1.1.2 The place names in this plan follow those recommended by J. Proctor and accepted by the Department of Lands and Survey, Sarawak (ref: 170/4-19/108/1; 30.6.79) (See Appendix I). The names of newly discovered caves are proposed and have been submitted to the DLS for consideration.

1.2 History of establishment and legal status

1.2.1 The following are tne main details of the history of the establishment of the Park.

July, 1961 A botanical expedition was mounted by the Forest Department, Sarawak, to Gunung Mulu and the Melinau limestone massif. The results of this expedition indicated the potential of the area as a national park and recommendations for its constitution as such were submitted tc the Conservator of Forests.

July, 1962	The Board of Trustees, National Parks, approved the proposals, submitted by the Conservator of Forests, to proceed with the constitution of the Park. Draft proposals were submitted to the Chief Secretary, who agreed with the proposals and indicated that the portion of the proposed Park falling within the Medalam Protected Forest should be excised from that Protected Forest when the Park was constituted.
Sept. 1962	Draft Gazette notification submitted to Chief Secretary.
August, 1963	Establishment of Malaysia, in which Sarawak became a federated State.
May, 1965	Governor in Council approved the publication of the Notice of Intention to create the Park, which was subsequently published in the Sarawak Government Gazette (Gaz. notification No. 867 of 1965).
July, 1965	Copies of draft proclamations indicating the Government's intention to constitute the Park forwarded to Residents, Fourth and Fifth Divisions, for posting.
Oct. 1965 to Dec. 1970	Investigation of claims against the National Park by the Residents, District Officers and Board of Trustees, National Parks.
Dec., 1970	Settlement of claims by Residents, Fourth and Fifth divisions. Revised boundary description prepared.

Note that as a result of submissions by Penghulu Baya Malang, representing the people living in the lower reaches of the Tutuh river, a substantial portion of the proposed park, lying between the Lutut river and a line drawn from Long Melinau directly to the Brunei border, was excised from the proposed Park.

Subsequently the Penghulu raised further objections to the constitution of the proposed Park.

Jan. 1971 Resident, Fourth Division, indicated that the interests of the Tutuh peoples had been adequately safeguarded.

Dec. 1971 Revised boundary description checked by Director of Lands and Surveys, and the location of the Berar river found to be misplaced. New revised boundary description prepared and approved by Director of Lands and Surveys.

June, 1972 Governor in Council approved the final constitution of the Park. Concurrence of Federal Government sought.

Sept. 1973 Chief Minister, Sarawak, ruled that the concurrence of The Malaysian Government to the constitution of the Park was not required.

27 Sept, 1974 By Sarawak Government Gazette Notification No. 2661, that part of the proposed Park falling within the Medalam Protected Forest was excised from that protected forest.

3 Oct., 1974 The Gunung Mulu National Park was finally constituted by the publication in the Sarawak Government Gazette of Notification No. 2852 (see Appendix II). Final proclamations indicating the constitution of the Park were forwarded to the Residents, Fourth and Fifth divisions for posting in their respective divisions.

1.2.2 The Gunung Mulu National Park is a fully constituted national park in Sarawak in accordance with the National Parks Ordinance (Cap. 127) of the State of Sarawak in Malaysia.

1.3 Present boundary (See Map 2).

1.3.1 For the greater length the boundary of the Park follows natural features, either rivers or ridges (usually watersheds), but in two localities cut lines constitute the boundary:

(i) In the extreme north, between Nanga Mentawai and the Brunei border for a distance of 3742 m (186 chains).

(ii) In the southeast, between the Tutuh river at the mouth of the Langsat river to the Melinau Paku river, six cut lines totalling 3963 m (197 chains) in length.

1.3.2 The principal natural features forming the boundary are as follows (clockwise from Nanga Mentawai):

Northern boundary: Sungei Medalam.

Eastern boundary: Ridge forming the watershed between the Seridan and Melinau rivers; the Sungei Ubung from its source to confluence with the Sungei Tutuh.

Southern boundary: Sungei Tutuh.

Western boundary: Melinau and Lutut rivers; the international border between Malaysia (Sarawak) and Brunei which follows the watershed between the Tutuh (Baram) river and tributaries and the Sungei Belait in Brunei.

1.4 Recommended extension to the Park

1.4.1 It is strongly recommended that the Park be extended to include the remaining portion of the Medalam Protected Forest as shown on Map 2. A slight modification of the northern boundary is recommended to ensure that on both banks of the Medalam river the Park starts at Nanga Mentawai. This proposal is elaborated and justified in Chap. 6.

1.5 Description in brief

1.5.1 The area of the Park is 52,864 ha (130,630 acres), and within this relatively small area there is a remarkable diversity of land forms and vegetation. Consequently the flora and fauna is exceptionally rich. Primary forest covers predominantly the whole area of the Park (very limited areas of ancient secondary forest, virtually indistinguishable from primary forest, on alluvium, may be discounted). The massif of Gunung Mulu, which ranges in altitude from 60m (200 ft) to 2,377 m (7798 ft), dominates the southern half of the Park. This mountain abuts onto the Melinau limestone massif which rises vertically in places to a height of c. 1700 m (5550 ft) - some of the highest limestone in the region. North-west of the limestone there is an extensive alluvial plain of exceptional interest, as little similar alluvium remains undisturbed in Sarawak and perhaps elsewhere in Borneo. This habitat has a particularly rich vertebrate fauna. The most northerly part of the Park, running up to the Brunei border, consists of low sharply dissected hills and extensive Quaternary terraces (also occurring on the alluvial plain) which are largely clothed in kerangas (tropical heath forest).

1.5.2 The local settled peoples in the Tutuh river to the west and in the Medalam river to the north east have limited hunting, fishing and gathering privileges over parts of the Park; and the nomadic Penan have similar privileges over the whole area of the Park so long as they maintain a nomadic existence. (See para. 3.1)

1.6 Access and communications (see Maps 1 and 2)

1.6.1 At present access to the Park is entirely by the two major river systems. The northern boundary, formed by the international border separating Sarawak and Brunei is totally uninhabited and apart from unknown Penan tracks, which are probably few in number and rarely used, there is no access from this direction. Furthermore, the headwaters of the Belait and Tutong rivers in Brunei are uninhabited and totally lacking in communications. The government of both Malaysia (Sarawak) and Brunei are likely to discourage any access into the Park along this stretch of the border. To the south the Park boundary mainly follows high and inaccessible ridges of Gunung Mulu itself. Here also general access into the Park is totally restricted and is confined to Penan trails. The headwaters of Sungei Tutuh, and its tributaries (especially Sungei Ubung) and also the S. Medalam are unnavigable, except possibly to specialized jet boats which are not in general use in Sarawak.

1.6.2 The principal access route into the Park is via the Baram and Tutuh rivers from Marudi to Long Melinau. The distance along the river is approximately 144 km (90 miles), but the duration of the trip is much dependent on the type of craft used and the state of the water. The minimum duration is about six hours, but the upriver trip by long boat usually takes a day and a half, with an overnight stop at Long Terawan.

1.6.3 A secondary access route, on the northern side, follows the Limbang and Medalam rivers. Entry into the Park itself can then be gained via the Sungei Mentawai, or the S. Tarikan to a point slightly downstream of Lubang Cina. Using a small longboat with a medium-sized outboard engine, L. Cina can be reached from Mendamit (the confluence of the Mendamit and Medalam rivers) in a day's journey, provided the water is reasonably high.

1.6.4 A helicopter pad has been established on Government land at Long Pala, outside the Park.

1.6.5 A proposed Government road, part of the Pan-Sarawak highway system, from Long Lama to Mendamit connecting the Fourth and Fifth divisions, is scheduled to pass through the north west part of the Park. The effect of this proposed road on the Park is elaborated in Chap. 5

1.7 Regulations

1.7.1 No specific regulations have been made for the Park.

1.8 Administration

1.8.1 In accordance with the National Parks Ordinance (Cap. 127), the legal authority for the control, management and maintenance of national parks is vested in the Director of Forests (formerly Conservator of Forests) Sarawak, who is responsible to the Minister of Forests.

1.8.2. Administration of national parks is undertaken by the National Parks and Wild Life Section within the Forest Department. The senior officer in charge (Assistant Conservator of Forests rank) is directly responsible to the Director of Forests. A more junior forest officer (Assistant Forest Officer rank) and two Forest Guards are stationed in Miri, and are responsible to the Section Forest Officer, Miri, for the administration of national parks in the Miri Section. The constituted national parks in this Section include, in addition to the Gunung Mulu National Park, the Niah National Park and the Lambir Hills National Park.

1.8.3 No Warden has been appointed for the Gunung Mulu National Park and there are as yet no park rangers specifically assigned to the Park. But two local Berawans, who had responsible positions in the labour force of the recent R.G.S./Sarawak Government expedition, have been enrolled as temporary rangers and have security duties within the Park. They also continue to service the automatic climatic recording equipment left by the expedition.

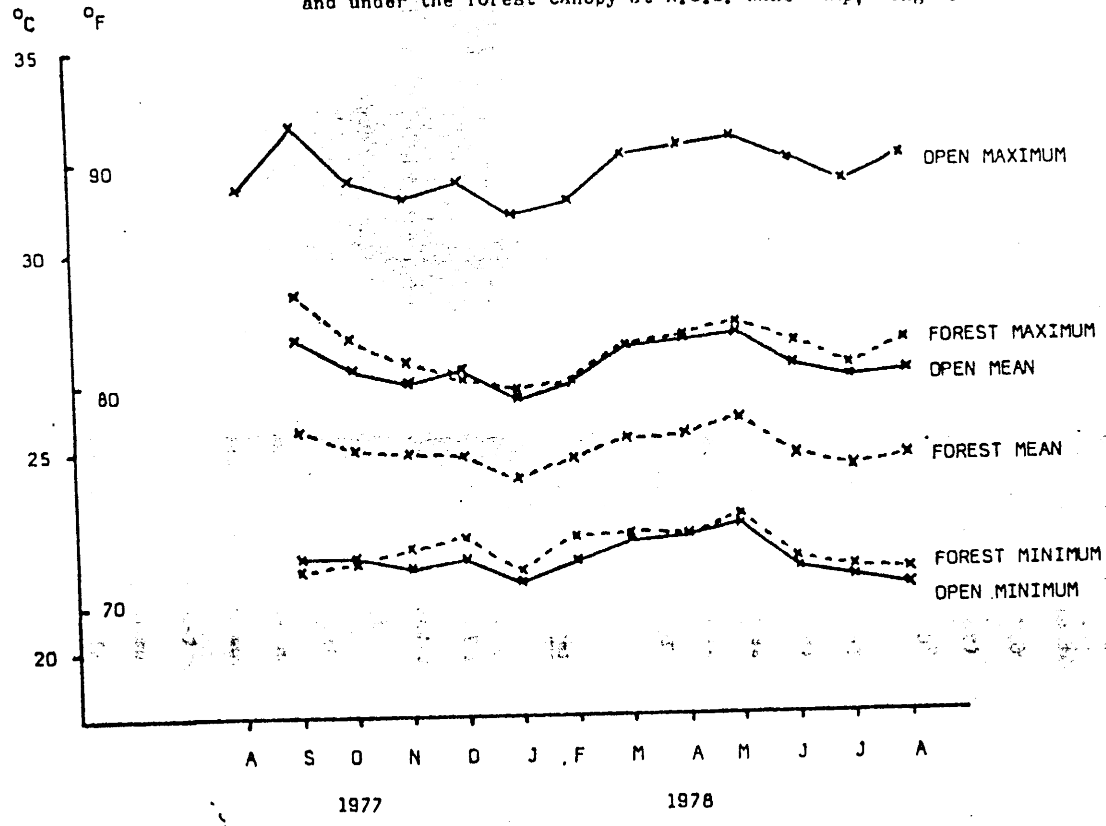
recorded at Melinau Gorge and at six sites of increasing altitude up Gunung Mulu, including the summit. It must be stressed that whilst this single year's records are sufficient for temperature and relative humidity, they are not adequate to draw positive conclusions for rainfall.

2.1.3 Temperature

2.1.3.1 Seasonal variations of temperature were minor. Mean monthly temperatures at Long Pala ranged from 26.3°C (79.3°F) in January to 27.9°C (82.2°F) in May, giving an annual range of only 1.6°C (2.9°F). Mean annual temperature for September 1977 - August 1978 was 27.1°C (80.8°F). See Figure 1.

2.1.3.2 Diurnal ranges of temperature were far greater than seasonal variation, the mean diurnal range being 9.7°C (17.5°F) Minimum temperatures, which occur around dawn, were remarkably consistent, almost always falling within the range 20.6 - 22.8°C (69 - 73°F) The lowest temperature recorded was 19.9°C(67.8°F) in January. Maximum temperatures varied much more depending largely on the degree of cloudiness or haziness during the day. Basically, three types of day were distinguished for lowland areas of the Park. In clear sunshine sustained until at least noon, maximum temperatures rose to between 32.2 - 33.9°C (90 - 93°F); in hazy sunshine, temperatures rose to around 31.1 - 31.7°C (88 - 89°F); and on overcast and rainy days, temperatures only rose to 26.7 - 30.0°C (80 - 86°F). The highest maximum recorded was 35°C (95°F) on 24 September 1977 during a spell of exceptionally dry weather. The number of days which were cloudy or rainy throughout the day was very small; most days with rain tended to cloud over in the afternoon and evening and hence after reasonably high maximum temperatures had occurred.

Figure 1 Seasonal variations in maximum, minimum and mean temperatures in the open and under the forest canopy at R.G.S. Base Camp, Long Pala



2.1.3.3 Mean temperatures under the rain forest canopy (Table 1) at Long Pala were around 2.2°C (4°F) below those recorded in the open, ranging from 24.2°C (75.6°F) in January to 25.7°C (78.3°F) in May. This difference is the result of markedly lower maximum temperatures under the forest canopy than in the open, as minimum temperatures are virtually the same under the forest as in the open. On sunny days, maxima under the forest reach between 26.7 - 28.9°C (80 - 84°F) and on rainy, overcast days between 25.7 - 26.7°C (78 - 80°F). Diurnal ranges are thus much lower under the forest canopy (5°C (9°F) than in the open 9.7°C (17.5°F).

2.1.3.4 Temperatures decrease with increasing altitude in the mountain areas of the Park. Table 2 and Figure 2 summarise these changes. The rate of decrease in temperature, in common with other humid tropical mountainous environments, is relatively low, following the low saturated adiabatic lapse rate once the condensation level has been reached.

2.1.4 Relative Humidity

2.1.4.1 At Long Pala relative humidity was recorded at 0700 and 1300 hours throughout the year in the open and at 0700 hours under the forest canopy (Table 3). Relative humidities were invariably high at dawn, either at or very near the dew point. Means at 0700 hours ranged between 96% - 99% in the open and 98% - 100% under the forest canopy. In the open on sunny days minimum relative humidities occurred in the early afternoon at the time of maximum temperature. There was a seasonal variation in 1300 hours relative humidity; the period of onshore winds from the South China Sea (NE Monsoon) from November to March had means of 85 - 89%, significantly

Table 1 Summary of temperatures in the open and under the rain forest canopy at Long Pala

September 1977 - August 1978

A. IN THE OPEN	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	YEAR
Mean Maximum	33.3	31.7	31.3	31.7	30.8	31.2	32.3	32.6	32.7	32.2	31.6	32.2	31.9
Mean Minimum	22.3	22.3	22.1	22.3	21.7	22.2	22.8	22.8	23.1	21.9	21.7	21.5	22.2
Mean	27.8	27.1	26.7	27.0	26.3	26.7	27.6	27.7	27.9	27.1	26.7	26.9	27.1
Diurnal Range	11.0	9.4	9.2	9.4	9.1	9.0	9.5	9.8	9.6	10.3	9.9	10.7	9.7

B. UNDER THE FOREST CANOPY	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	YEAR
Mean Maximum	28.9	27.8	27.2	26.8	26.5	26.7	27.6	27.8	28.1	27.8	27.0	27.6	27.4
Mean Minimum	22.0	22.2	22.5	22.8	21.9	22.8	22.8	22.8	23.3	22.1	21.9	21.8	22.4
Mean	25.5	25.0	24.9	24.8	24.2	24.7	25.2	25.3	25.7	24.8	24.4	24.7	24.9
Diurnal Range	6.9	5.6	4.7	4.0	4.6	3.9	4.8	5.0	4.8	5.5	5.1	5.8	5.0

- All Temperatures in Degrees Centigrade

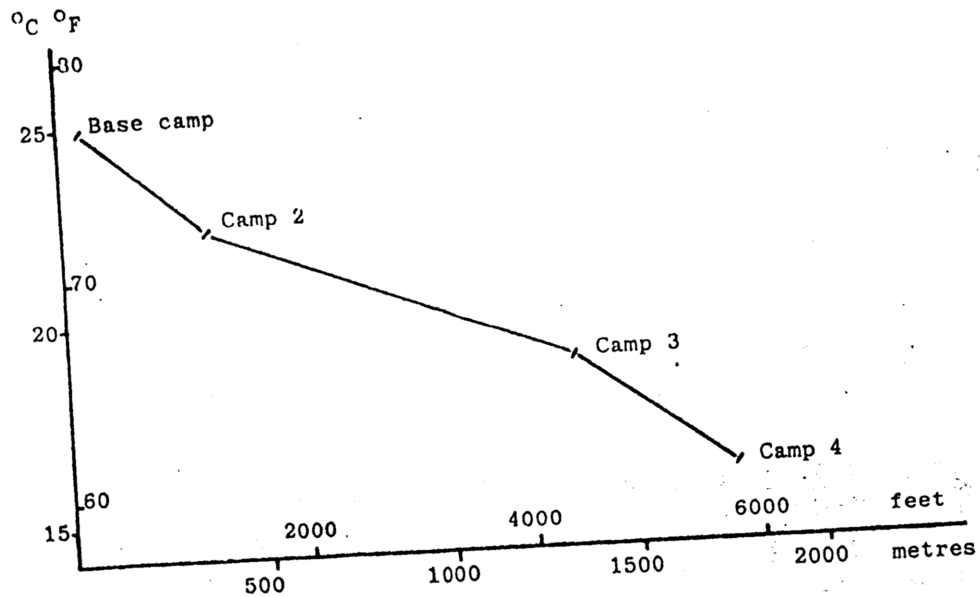
Table 2 Altitudinal variations in temperature in Gunung Mulu under the forest canopy (in °C.)

Location	Altitude	Mean Maximum	Mean Minimum	Mean	Diurnal Range
Long Pala	100'	27.4	22.4	24.9	5.0
Camp 2	1200'	23.9	20.7	22.3	3.2
Camp 3	4400'	20.8	17.2	19.0	3.6
Camp 4	5800'	18.6	14.1	16.3	4.5

Table 3 Relative humidity at Long Pala

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Year
<u>In the open</u>													
0700 hrs	93.7	96.1	95.9	98.7	98.9	98.3	98.3	97.5	97.1	96.4	96.4	96.3	97.3
1300 hrs	75.4	75.7	85.1	86.7	88.1	89.3	87.3	ND	ND	76.3	76.9	71.6	81.2
<u>In the forest</u>													
0700 hrs	98.9	99.9	99.6	99.9	99.9	99.6	99.3	98.6	98.5	98.2	98.2	97.9	99.0

Figure 2 Altitudinal changes in temperature under the forest canopy on Gunung Mulu



higher than during the SW Monsoon (June to October) in which winds had a much greater land distance to travel over Borneo. Relative humidities under the forest canopy even in the afternoon of the hottest days rarely fell below 90% even in the SW Monsoon.

2.1.4.2 Relative humidities also decreased markedly with altitude. Hourly observations on G. Mulu over a period of several days in December 1977, showed that relative humidities were always at or just below dew point, always 95% or higher. This has important consequences in reducing evaporation rates and accounting for the distribution of the 'mossy' upper montane forest.

2.1.5 Rainfall

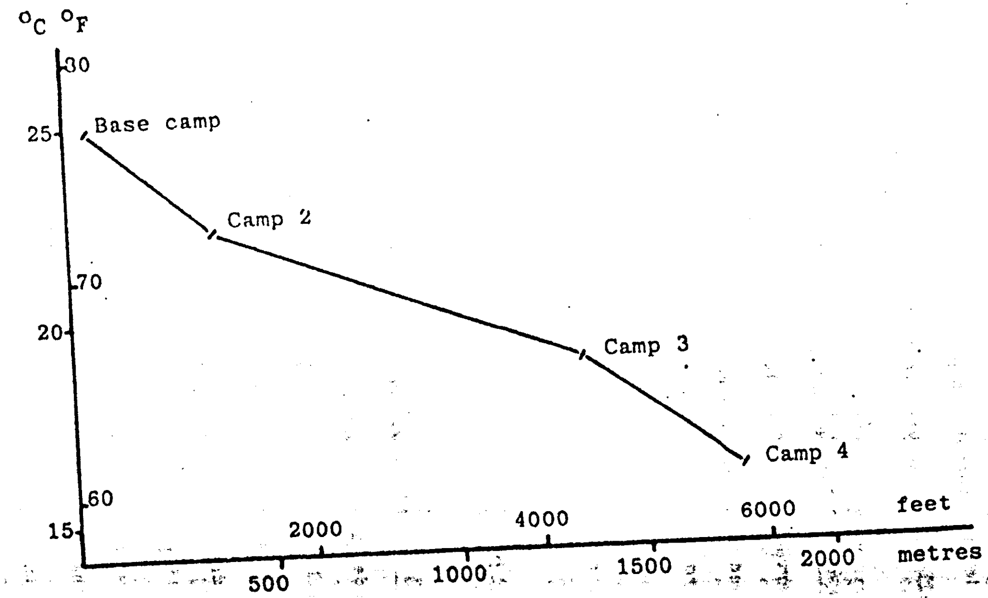
2.1.5.1 Rainfall was recorded at eight locations at widely varying altitudes in the Park from August 1977 onwards (see Table 4). Annual rainfalls throughout the Park are very high, with all gauges except the summit of Mulu recording over 5000 mm (200 ins). Although there is no marked dry season in an absolute sense, the rainfall regimes show distinct seasonality (Figure 3). Maxima in rainfall occurred just after the equinoxes in April/May and October/November and rainfall remained high during the months of the NE Monsoon. There is evidence of a third maximum in January at the height of the NE Monsoon in some of the Mulu stations. The months of August and September were very dry in comparison with all the other months of the year. At Long Pala only 98 mm (3.88 ins) fell in September 1977 and 134 mm (5.29 ins) in August 1978; all other months received over 253 mm (10 ins). This drier season, which may have important implications for the rainforest ecosystem, occurs at the height

Table 4 Monthly rainfall in the Gunung Mulu National Park, September 1977 - August 1978

Location	Grid Ref.	Altitude	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	YEAR
		m													
Long Pala	823219	65	99	547	726	325	437	401	327	607	727	396	361	134	5087
Camp 1	856229	150	111	687	790	403	406	347	348	415	602	331	514	174	5107
Camp 2	861226	500	102	608	931	416	386	366	411	494	427	550	565	182	5518
Camp 3	872222	1320	83	698	929	450	388	416	385	454	660	453	475	185	5575
Bukit Tuman	876219	1700	(132)	769	1082	516	632	497	490	498	866	579	585	158	6802
Camp 4	887227	1800	127	698	838	420	356	490	436	528	827	374	370	215	5678
Mulu Summit	895227	2376	Insufficient Information.												4882
Molinau Gorge	875277	150	(215)	784	710	470	355	551	394	359	670	605	501	84	5698

Rainfall data in millimetres

Figure 2 Altitudinal changes in temperature under the forest canopy on Gunung Mulu



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Melinau Gorge	875277	150	(215)	784	710	479	355	551	394	359	870	605	501	84	5698

Rainfall data in millimetres

Figure 3 Rainfall regimes of the Gunung Mulu National Park and adjacent areas of Sarawak

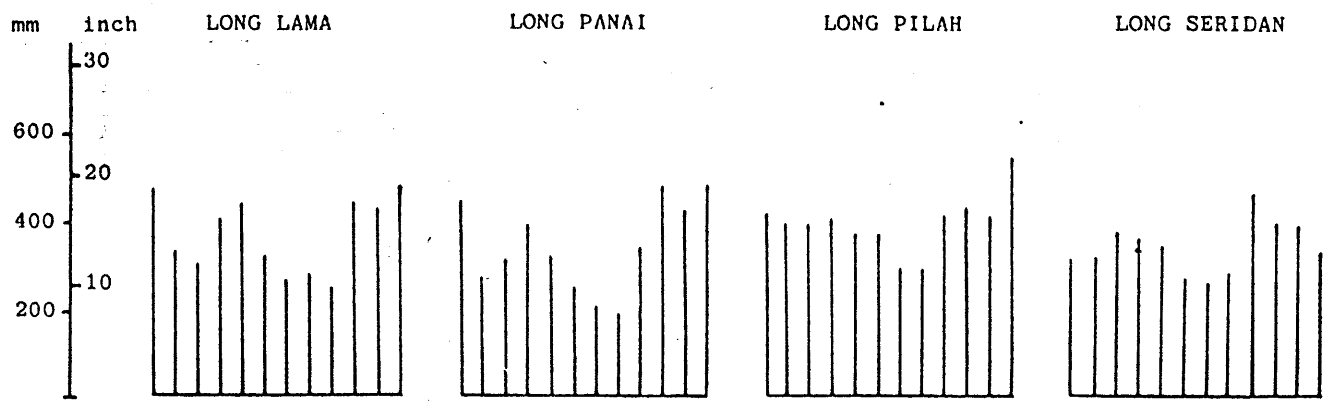


Figure 3 (continued)

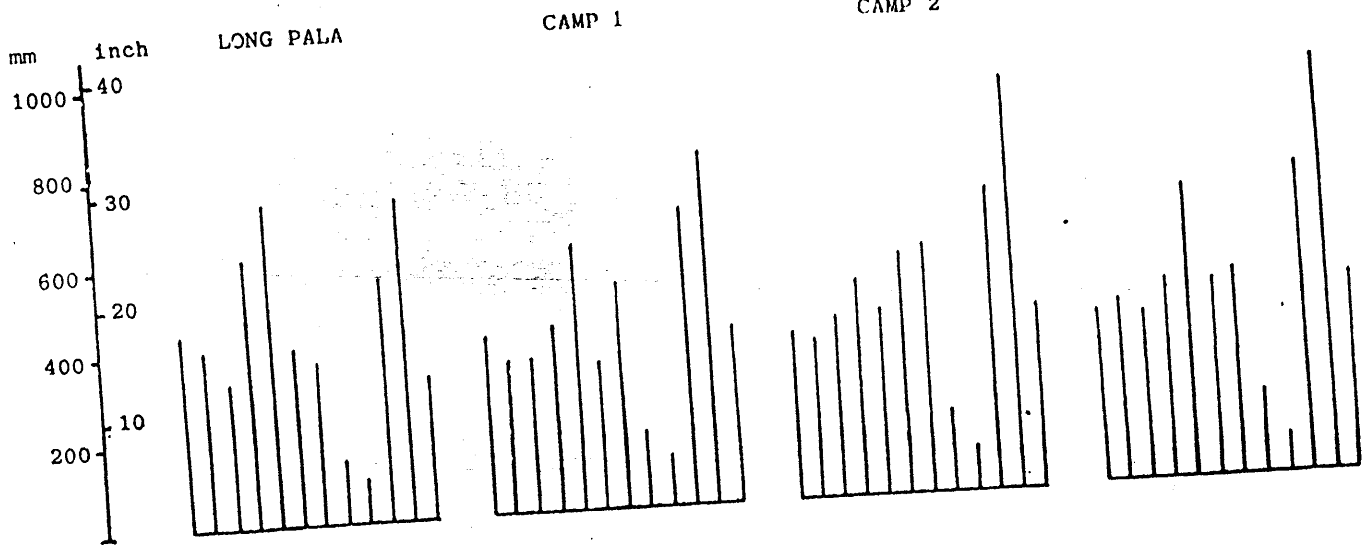
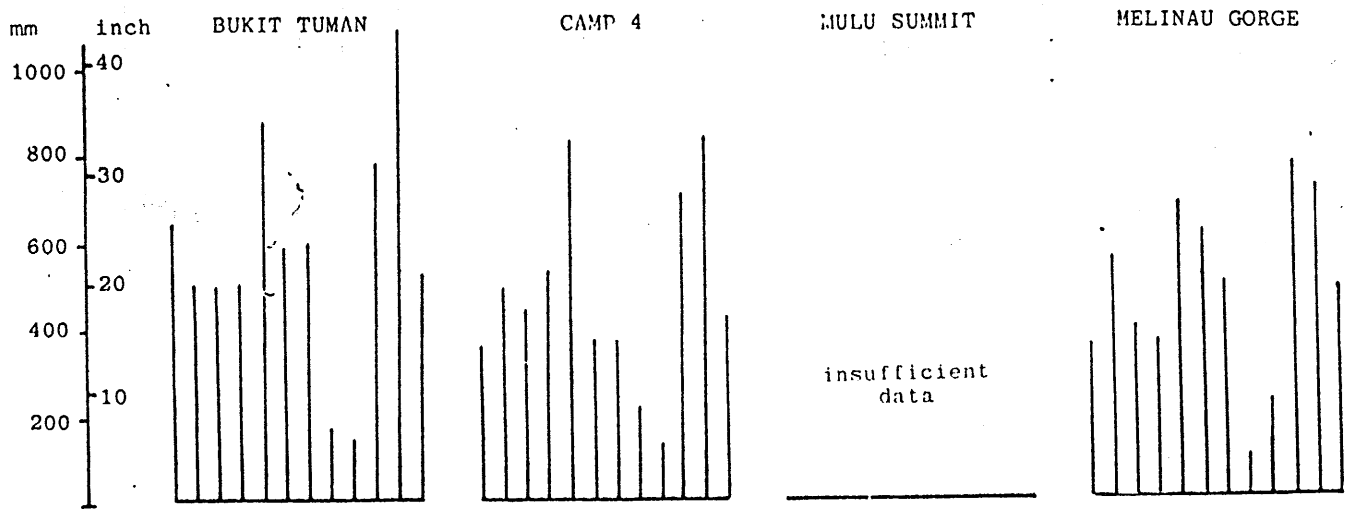


Figure 3 (continued)



of the SW Monsoon with its drier air having passed over the landmass of southern Borneo.

2.1.5.2 Figure 4 shows how annual rainfall increased and then decreased with altitude up the western ridge of Gunong Mulu, from 5076 mm (200 ins) at Long Pala to a maximum of 6802 mm (268 ins) at around 1650 m (5500 ft), before decreasing to 4873 mm (192 ins) on the summit of Mulu. The decrease in rainfall above 1650 m may be due to a number of factors: first, it was observed that many convectional storms tended to follow the valleys rather than cross the higher mountain ridges where the last two gauges were sited: second, the zone of maximum precipitation may occur around 1650 m; third, the relief of the peak of Mulu itself may tend to cause air to flow around rather than over it leading to less uplift and rainfall; fourth, some of the decrease may have been due to exposure of the gauges to high winds.

2.1.5.3 At Long Pala, rain fell on 275 days, with significant rain >2 mm (0.10 ins) on 226 days. Most days received between 2-25 mm but heavy falls of more than 25 mm occurred on 66 days. Seven falls of 76 mm (3 ins) or more in a day occurred, the highest fall recorded being 187 mm (7.35 ins) on 2 November 1977. The daily and monthly rainfall statistics are summarised in Table 5.

2.1.5.4 Heavy daily falls were concentrated into the peak wet months of October/November and April/May. The reality of the drier season in August/September is emphasized by the higher frequency of days with no rainfall (16 in August 1977, 15 in September 1977 and August 1978) in those months.

Figure 4 Annual rainfall and altitude on Gunung Mulu

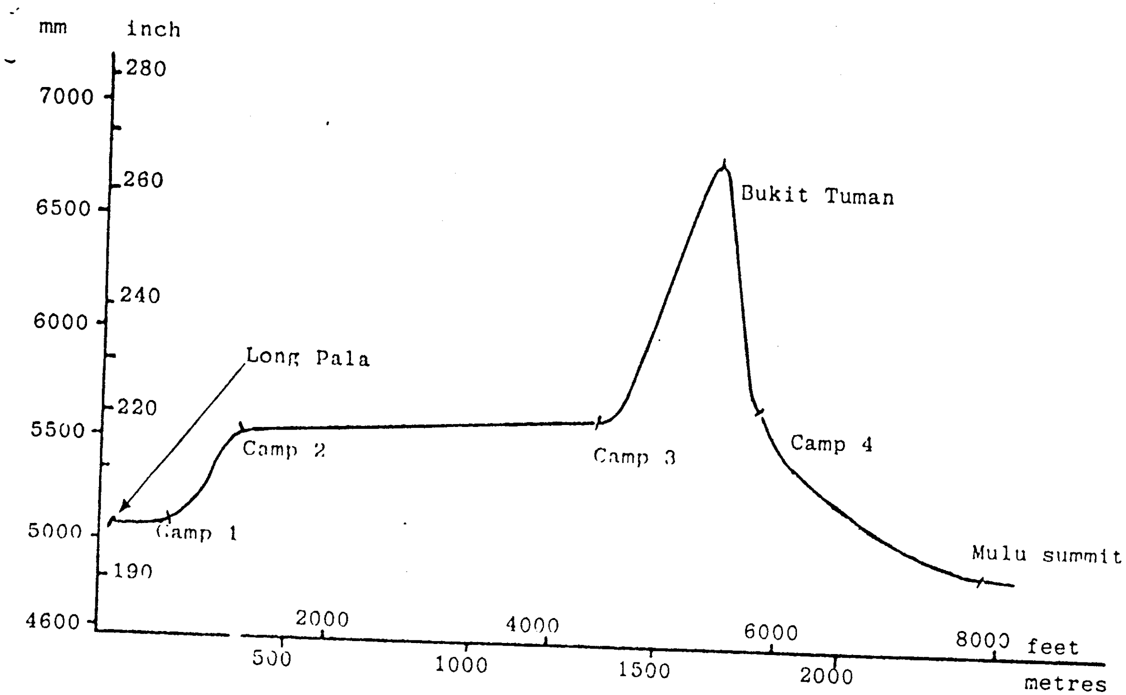


Table 5 Daily rainfall summary at R.G.S. Base Camp, Long Pala : August 1977 - August 1978

Month	Rainfall mm	Max in a day mm	No Rain or Trace	Frequency of Days with : ≥0.2 mm	≥2.5 mm	≥12.7 mm	≥25.4 mm	≥76.2 mm	≥127 mm
AUG 1977	279	56	16	15	13	11	3	0	0
SEP	89	17	15	15	11	3	0	0	0
OCT	547	123	6	25	22	12	7	2	0
NOV	728	167	4	26	25	13	10	1	1
DEC	325	69	5	26	21	8	3	0	0
JAN 1978	437	69	6	25	20	12	6	0	0
FEB	401	83	8	20	19	9	5	1	0
MAR	327	69	3	28	20	9	4	0	0
APR	607	112	4	26	20	12	11	1	0
MAY	727	120	8	23	22	16	10	2	0
JUN	398	72	10	20	15	12	6	0	0
JUL	301	77	6	25	21	7	3	1	0
AUG	134	49	15	16	10	3	1	0	0
YEAR SEP 1977 - AUG 1978	5087	167	90	275	226	116	66	8	1

An automatic raingauge was also operating during the period and analysis of the diurnal variation in rainfall is being made.

2.1.6 Wind and Evaporation

2.1.6.1 Systematic records of these climatic elements were not made, but the following observations were made. Local mountain wind systems with katabatic winds at night and anabatic winds by day occur widely and the former may be partially responsible for triggering off convectional cells in the valleys. Wind speeds generally in the Park are low; however on mountain ridges wind speeds may be high for long periods, particularly in overcast conditions and during rainfall.

2.1.6.2 But long-term measurements in NE Sarawak suggest annual evaporation of the order of 60" in lowland areas. Evapotranspiration losses have been shown (Brunig 1970) to vary immensely with vegetation type and structure in Borneo, and such variations will certainly apply between the various vegetation types of the Park. Also evapotranspiration will vary immensely with altitude and exposure to wind. Generally with decreased temperatures in the mountains evapotranspiration rates will be lower, but locally, especially on mountain ridges, rates may be excessively high because of wind. The vegetation has usually adapted to such conditions by cutting down evapotranspiration losses through a lower, streamlined canopy structure and thicker and smaller leaf forms.

2.2 Geology

Account contributed by A.C. Waltham.

2.2.1 Introduction

2.2.1.1 Gunung Mulu lies in the North-west Borneo geosynclinal belt, which was active almost throughout Tertiary times. This meant that for more than 50 million years the area was in a rapidly subsiding marine trough, in which accumulated enormous thicknesses of sediments. Since then the folded sedimentary rocks have acted as a flank unit on the Sunda Shield, giving the area a stable, relatively earthquake free environment at the present time. During the last 10 million or so years, the major geological processes have been erosion, landscape evolution, and deposition of considerable quantities of alluvium.

2.2.1.2 The boundaries of the Park embrace a cross section of the geology which includes all the major contrasting lithological units of the geosynclinal belt (Figure 5). With a regional dip to the north west the rocks occur in a sequence from the oldest on Gunung Mulu itself to the youngest on the Brunei frontier. In general terms the surface geology is remarkably simple. The succession of rocks is outlined in Table 6, though this can only summarise the ages as most lithologic boundaries are diachronous in detail. Much of the following lithologic descriptions are abstracted from the major published references (Liechti 1960, and Wilford 1961), with additional data on the Melinau limestone from Adams (1965) and field observations on the Mulu Expedition.

2.2.2 Mulu Formation A 4000-5000 metres thick series of shales and sandstones, the Mulu Formation, crops out over the whole south eastern half of the Park, including Gunung Mulu itself (see Map 3).

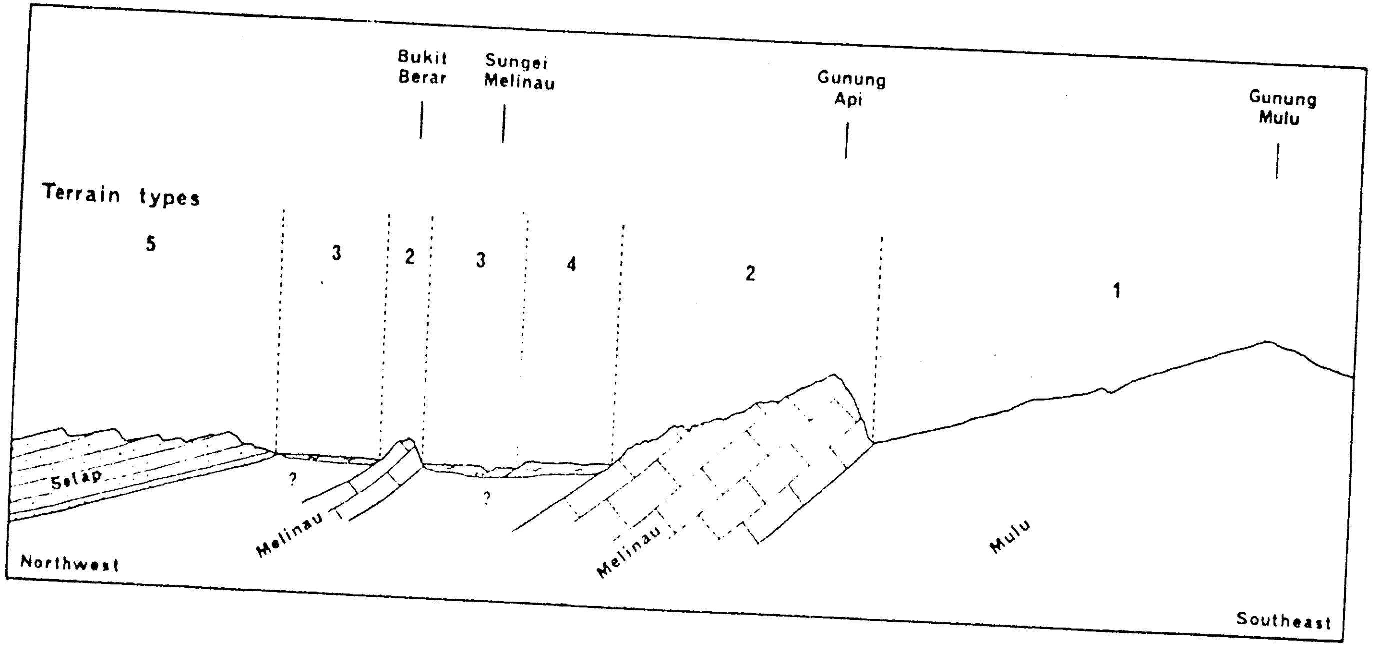


Figure 5 Diagrammatic cross section through the major terrain and land-form types of Gunung Mulu National Park.

Table 6 Rock sequences in Gunung Mulu National Park.

<table>
<tr><td>Recent</td><td>Alluvium</td></tr>
<tr><td>Pleistocene</td><td>Terraces</td></tr>
<tr><td colspan="2">Major unconformity</td></tr>
<tr><td rowspan="3">Miocene</td><td>Belait Formation</td></tr>
<tr><td>Setap Shale Formation</td></tr>
<tr><td rowspan="3">Melinau Limestone Formation</td></tr>
<tr><td>Oligocene</td></tr>
<tr><td rowspan="2">Eocene</td></tr>
<tr><td rowspan="2">Mulu Formation</td></tr>
<tr><td>Paleocene</td></tr>
</table>

2.2.2.1 Thin alternating beds of shale and sandstone, best described as greywacke facies, form a mostly unfossiliferous and monotonously repetitive unit. The shales are submetamorphic, locally well cleaved and in some places sericitised; many of the outcrops could be described as poor slate or even hornfels. The sandstones are mostly poorly bedded dense grey quartzite. Over north-west Borneo as a whole, shales dominate in the Mulu Formation, but in parts of the Park sandstones are dominant, which may account in part for the topographic prominence of the Gunung Mulu massif.

2.2.3 Melinau Limestone Formation

2.2.3.1 The most distinctive rock formation in the Park is the Melinau Limestone which forms a line of spectacular mountains across the heart of the Park just north-west of Gunung Mulu. Ranging to a thickness of well over 2000 metres the limestone only forms a massive lens, as it thins to nothing just outside both northern and southern boundaries of the Park. Its prolific foraminifera fossils have permitted its stratigraphic subdivision by Adams (1965). This has revealed that the limestones of Bukit Berar and the Gua Payau hills are slightly older than those forming the main outcrops on Gunung Api and G. Benarat, but the age has little bearing on lithology.

2.2.3.2 Most of the limestone is exceptionally massive, consisting of white or grey calcilutite or fine calcarenite. Recrystallisation has been extensive and has given some bands the appearance of marble. It has also destroyed many of the fossils. Corals, bryozoans, lamellibranchs and gastropods form a sparse macrofauna, though microfossils are common, and some large 'forams' are spectacularly abundant at isolated horizons. There are limited occurrences of autobreccia. A white patina due to weathering obscures lithological detail in most outcrops, but considerable local variation is visible in many of the cave exposures. Bedding planes picked out by solution are normally on contacts of contrasting lithologies, are locally stylolitic, and are noticeably devoid of shale partings. The limestone is extremely pure, with insolubles less than 1%. Dolomite content ranges 2-20%, which is probably mainly of primary origin. However there are some outcrops, notably on Bukit Berar, of almost pure dolomite (with a typical dirty, sugary appearance), which suggest at least some secondary introduction of magnesium.

2.2.3.3 The massive lenticular form of the Melinau Limestone, and its relative lack of internal structure, both indicate the possibility of its origin as a true bioherm. At the same time the total lack of exposure of its upper margins, beneath the alluvial plains of the Melinau and Medalam, leaves unanswered questions provoked by any biohermal origins. Shepherd (1954, in Liechti, 1960) mapped the bedrock geology of these alluvial plains entirely as Melinau Limestone. However exposure is limited to the isolated hills (Bukit Berar being the largest) and scattered pinnacles which project through the swamp and forest floor. It would be quite reasonable, in the light of an environment of restricted biohermal limestone development, to suggest that each outcrop was its own limestone bioherm. Differential erosion would then ensure that the limestone formed the projecting outcrops, while the intervening alluvium covered lowland could be floored by shale. Bedrock beneath the alluvium may therefore be either limestone or shale. At the present time it is impossible to be any more conclusive than to offer the two alternatives; field workers remain divided in their opinions. In addition, there are isolated outcrops of well lithified shale unconformable on the limestone in both the Melinau Gorge and Hulu Air Jernih. Besides implying the possibility of exhumed topographies, these could add a further complication to the paleogeography of the Melinau Limestone itself.

2.2.4 Setap Shale Formation

2.2.4.1 The north west corner of the Park, beyond Bukit Berar, is largely on this thick sequence of shales and sandstones. The Setap Formation ranges 4000-5000 metres thick, and could possibly extend to more shale under the Melinau plain. Most of the succession is made of fine dark clay-shales and minor siltstones, though about 20% of the total is sandstone. These fine grained, quartzitic sandstones are thinly bedded and mostly in units of a few metres thickness within the shale succession - giving the Setap an overall facies most analogous to flysch. Some calcareous shales occur and there are scattered small biohermal limestones, representing the dying remnants of the Melinau Limestone facies.

2.2.5 Belait Formation

2.2.5.1 Along the border with Brunei, the Park encloses a narrow outcrop of the Belait Formation. Most of these beds crop out in Brunei, but a sequence perhaps 2000 metres thick is exposed on the Sarawak side. They represent a sandier continuation of the Setap Formation, consisting of alternating shales and sandstones but with the latter dominant. The sandstones form units up to 15 metres thick of pure, hard, grey material, while the interleaved shales are generally rather silty or sandy and laterally discontinuous.

2.2.6 Quaternary Sediments

2.2.6.1 Following the Pliocene termination of geosynclinal development and a subsequent regional uplift, Pleistocene and Recent times saw the deposition of extensive fluvial sediments lying unconformably on the eroded Tertiary rocks. Early Pleistocene sediments are preserved as remnants of terraces perched on the sandstone ridges around 200 metres above sea level along the northwestern edge of the Park. Equally extensive are the remnant tracts of Middle Pleistocene alluvium. A late phase of uplift has left these forming terraces around 20-25 metres above present river levels in the Melinau and Tarikan plains, and also another slightly older terrace about 35 metres higher than that. Locally known as the Middle Terraces, these consist of well rounded sandstone cobbles in an uncemented matrix of sand and clay. Limestone boulders are noticeably scarce within these extensive and spectacular alluvial conglomerates. Recent sediments consist mainly of the modern flood-plain alluvium, notably of the Melinau and Tarikan rivers, and also the Low Terrace about 6 metres higher. The material is finer grained than the Pleistocene terrace sediments, and is mainly clay or sand, but does contain local developments of boulder beds. Locally there are low terraces, composed mainly of boulders, around 2-3 m above the flood plain. In all, these alluvial sediments constitute a complex sequence of terraces of unknown total thickness in the Melinau plain. Other recent sediments include scree deposits of breccia on the limestone slopes, and these are locally well cemented. The northern tip of Gunung Api, traversed by the path to the Pinnacles, is a massive slope of poorly cemented breccia which is probably quite a thin sheet. Tufa is locally well developed in the Melinau Gorge; at the same locality landslide or scree breccia lies on low terrace fragments as testimony to its relative youthfulness.

2.2.7 Structural geology

2.2.7.1 The north westerly regional dip in the Park is a long term feature of the deepening of the northwest Borneo geosyncline and the folding into it. A regional dip in the order of 30° is realistic for the northern bulk of the Park, but Liechti (1960) places an anticlinal axis through the Gunung Mulu massif which must indicate south easterly dips on the southern flanks of the mountain. A cross section in Adams (1965) gives a dip of 23° to the Melinau limestone, but both the various cliffs and the underground exposures reveal dips ranging from 20° to 50°, to the north west, and the mean figure must exceed 23°. Largely on the basis of similar foraminifera in the limestones of Gunung Api and Bukit Berar, a syncline and the large Melinau Fault have been postulated beneath the sediments of the Melinau plain. While this is unproven in detail, folds with local dip reversals do occur within the limestone.

2.2.7.2 The main folding was of Pliocene age, and has also resulted in tight folds and even isoclines within the Setap and Mulu Formations, particularly against the resistant Melinau Limestone bioherms. The same north-west/south-east compression has developed a poor slatey cleavate within the shales of the Mulu Formation. Joint patterns, probably including many reverse faults, have not been mapped in the clastic formations. However underground exposures in the limestone have revealed up to four distinct sets of high angle joints and occasional faults parallel to or closely oblique to the strike. Dip fractures are noticeably less well developed and are largely restricted to widely spaced faults.

Pre-Pliocene tectonics only accounted for the facies changes in the sedimentary sequences and a debatable extent of local unconformities. Since the Pliocene disturbance, movements have been limited to uplift, Within the Park the Quaternary terraces show no recognisable dip, but regional correlation of terraces outside the Park indicates that the Gunung Mulu area was a centre of uplift which decreased towards the coast.

2.2.8 Geological History

In summary, the geology of the Park is a classic example of evolution on the flank of a developing and then waning geosyncline. The sedimentary sequence is therefore long and varied and was followed by a degree of folding. Subsequent uplift has permitted deep excavation and spectacular landscape development with alluviation only on the lower levels.

2.2.9 Terrain units The relatively simple overall geology allows the Park to be divided into five distinctive terrain units. As delimited on the geological map (Map 3) and diagrammatically represented on the cross section (Figure 5) these are, broadly in sequence from east to west, as follows :

2.2.9.1 Mulu sandstones : Steeply dissected slopes, commonly unstable, with sandy soils and dendritic gully drainage.

2.2.9.2 Melinau Limestone karst: Mountainous relief with precipitous bounding cliffs, patchy organic soils and underground drainage.

2.2.9.3 Floodplains: Alluvial forest, frequently inundated, with clay and silt deposition.

2.2.9.4 River Terraces: Relatively flat ground with sandy soils, better drained and mainly supporting kerangas vegetation.

2.2.9.5 Setap scarplands: Small sandstone scarps alternating with clay valleys bearing a trellised drainage network.

2.3 Geomorphology

Account contributed by D.B. Brook, M. Laverty and A.C. Waltham.

2.3.1 Introduction. The following paragraphs describe first the variety of landforms in the Park; secondly the processes that are now modifying these landforms; and thirdly their historical development up to the present day, since tectonic forces exposed the area to subaerial geomorphological influences. It should be emphasised that data collection has been biased towards the more frequented rivers, ridges and pathways of the central NE-SW segment of the Park.

2.3.2 Mulu Formation

A high density dendritic drainage pattern is deeply incised into the rocks here (see Map 4A); lithological changes are of subordinate importance and give rise to only local expression as breaks of slope. The stream talwegs are steep and uneven, with large rounded boulders prominent. Interfluvial slopes are very steep - 45° to 60° and more - and there are cliffs near the summit of G. Mulu. The divides are sharp ridges with occasional cols, which may have been accentuated by thetracks of larger animals, such as rhinoceros. Of the five main ridges radiating from G. Mulu, the NE ridge continuing round to G. Tamacu forms part of the major watershed between the Limbang and Baram catchments. None of the catchments (from the largest (S. Ubung) to the smallest) has yet been studied morphometrically in whole or in part, although such studies would be interesting (e.g., why is the S. Tapin catchment so asymmetric ?). The southern boundary of the Park, formed by the S. Tutuh, is of interest because of its considerable gorge and rapids.

2.3.3 Melinau Limestone Formation

This forms a conspicuous range of mountains in a NE-SW strike oriented ridge. It includes G. Api and G. Benarat; the large isolated hills bounded to the south-east by the Melinau Fault (e.g. Bukit Berar); the smaller isolated hills (e.g. Bukit Lubang Kelaiq); isolated cylindrical towers; and small bedrock outcrops of the jagged limestone surface which is believed to underlie the alluvial plains. Prominent gorges completely transect the mountains (e.g. Melinau Gorge) or partially (e.g. Hulu Air Jernih), but surface water flow here is either actually on Mulu Formation rocks or is inhibited from sinking into the limestone by low hydrological head or impermeable alluvial cover. Elsehwere, precipitation flows only for short distances over bare rock and disappears down fissures without forming streams.

Several broad, sub-planar surfaces may be surmised to be remnants of former erosion surfaces, now uplifted and tilted. Upon these remnants, geomorphic processes have acted to give the present limestone surface, which is characterised either by variants of polygonal karst depressions and intervening hill ridges; or by the surface of the hill ridges which consist of limestone pillars with rounded tops separated from each other by deep narrow fissures, the pillars becoming smaller and more spikey downslope to form pinnacles. The 'Pinnacles' on G. Api are spectacularly large examples of such forms and here occupy a shallow valley bottom, but depressions investigated further south on G. Api have floors of limestone fragments and detached blocks which rest on residual, fissured limestone. Karren of various forms and dimensions are developed on many of the surfaces and vary according to factors such as the aspect, the microclimate (e.g. influence of mists on 'the Pinnacles') and the presence or absence of a soil or vegetation cover (e.g. rounded forms tend to occur under cover and very sharp-edged forms in exposed situations).

The bounding slopes of the large-scale karst landforms are made up of combinations of : vertical cliffs, limestone block scree slopes (which are often cemented) and bedrock inclines of up to 30°. The cliffs are often notched by swamp notches and /or foot caves, which may also be seen high above present erosion levels and hence provide significant evidence about the evolution of the area.

Tufaceous deposition of calcium carbonate is often evident upon cliffs as well as elsewhere where small seepages of oversaturated water emerges from the limestone.

2.3.4 Caves of the Melinau Limestone

2.3.4.1 About 50 kilometres of caves are now known to exist in the Gunung Mulu National Park (see Map 4). Although rivers do flow through some of the caves, most passages are abandoned phreatic conduits (tunnels which were originally developed when they were full of water under pressure), some of which almost certainly date back well over a million years. Their main role when active was drainage of the limestone along the bedding towards the southwest, but the modern low level of the Melinau plain has caused a new pattern of cave drainage to the northwest and west to be superimposed on the fossil systems. Only the main caves are briefly described here; fuller details including descriptions of all the caves are in Brook and Waltham (1978).

2.3.4.2 Gua Payau and Lubang Hijau represent two fragemnts of an enormous trunk cave which used to drain south towards the Sungei Tutuh, taking water from the Melinau Paku valley and possibly further north. Gua Payau, nowhere less than 100 metres in diameter in its kilometre length right through the hill, is probably the largest cave passage in the world. Lubang Hijau is smaller in section, but longer, and a completely eroded sediment fill makes its traverse very much more difficult than Gua Payau.

2.3.4.3 Lubang Angin carries drainage through the limestone ridge from the Melinau Paku valley to the Sungei Melinau, and its only entrance opens on to the bank of the latter river. The main passage is large and level with the river meandering across its floor, but the upstream half of the cave is more complex with an extensive high level series and converging streamways.

2.3.4.4 Gua Air Jernih is the longest system yet explored in the Park with 26 kilometres of passages. The Sungei Air Jernih is almost certainly the water from what the expedition called 'Hidden Valley' Hulu Air Jernih and it may be followed upstream for nearly 3 kilometres from the resurgence close to the Sungei Melinau. This river passage is one of the finest in the world, over 20 metres wide and 30 metres high, with the river deep enough to permit longboat navigation over practically its whole length. At the downstream end there is a complex of inlet caves which drain floodwater in from the Melinau Plain. Near the upstream end, an obscure route allows access up into the main fossil trunk passage which extends northeast for nearly half the length of Gunung Api. Most of this is again 20-30 metres high and wide. Some branches end at other entrances, while others terminate in boulder chokes.

2.3.4.5 Lubang Sendirian is one of the large open shafts on the slopes of Gunung Api which can be seen from the air. At the surface it is 100 metres in diameter and its overhanging walls drop 150 metres to a boulder slope leading down to greater depths which remain unexplored.

2.3.4.6 Gua Ajaib, located in the north wall of Hulu Air Jernih, is an entirely fossil cave system of very considerable age. It has a constricted and difficult entrance passage leading to a series of spacious chambers. These are distinguished by their profusion of calcite and gypsum decorations, with every type of deposit from massive flowstone to delicate helictites occurring in abundance. Without doubt Gua Ajaib is the most beautifully decorated cave in the whole of Malaysia.

2.3.4.7 Gua Sungei Tarikan contains the underground course of the Sungei Tarikan, which can be traced for nearly 2 kilometres upstream from its well-known resurgence; the source of the river is not known. At least 12 more entrances, along the base of the limestone cliffs east of the resurgence, lead into a complex of caves which connect to the underground river. Some of these passages are fossil but many carry floodwater in from the terraced alluvial plain.

2.3.5 Alluvial Plain

Much of the Park to the west of the main limestone mountains consists of low, but rarely flat, land covered with alluvial deposits ranging from clays and silts up to sandstone cobbles and boulders. Limestone is believed to underlie this area where it is seen as isolated outcrops through the floodplains and in river beds. Some undulations in the surface may reflect buried bedrock topography, but another major cause may be the abundance of abandoned river channels gradually being filled in. Present drainage channels are very steep sided and, because they are mainly active during storms, have been compared to tidal creeks in their behaviour. Enclosed depressions, 0.5-10 m in diameter and up to several metres deep can be found in the alluvial deposits; they may represent collapse into voids formed by subterranean drainage in the deposits themselves (soil pipes), or collapse into limestone caves, or subsidence into depressions caused by sub-soil limestone solution. Tree trunks form centres for alluvial islands up to 1 m above the general plain level.

Low alluvial terraces composed of sandstone boulders and quartz fragments rise 3-4 m above alluvial plain levels and contribute to the undulation of the plain. Medium height terraces, with steep margins and slopes of 36° or more, rise up to 58m above the adjacent plain level. The surface of the medium-highest terraces undulates gently; they are composed of well rounded sandstone boulders in sandy matrix and slope to the north-west and are especially dissected in this direction by what are described as 'tea coloured streams'. The terraces bear witness to the uplift which initiated the processes now destroying them.

2.3.6 Setap Shale and Belait Formations

These formations are deeply dissected by streams forming a trellised drainage network on the more steeply dipping beds in the southeast of the outcrop with sandstone cuestas forming the interfluves. A more dendritic network near the northwest border of the Park is largely established on old terrace remnants. The Setap Shale is covered over a large proportion of its outcrop by terrace deposits which have not been investigated since the earlier mapping by Shell and British Borneo Geological Survey geologists. They were then described as medium high terraces similar to those described on the alluvial plains, and also including remnants of an even earlier depositional phase. These high terraces at about 210 m above sea level form a well dissected ridge at about the same height as the summits of sandstone cuestas to the west, and are valuable evidence for reconstructing the geomorphic history of northwest Sarawak and Brunei.

2.3.7 Erosion processes at present modifying these land forms

2.3.7.1 Mulu Formation. The erosion of the Mulu Formation rocks tends to be by physical entrainment in water and stream transport as colloidal, suspended and bed load; the siliceous nature of the rocks is shown by the only significant dissolved component of the drainage water being silica. Enough data has been collected to give a tentative idea of erosion rates and hydrological pathways, but more detailed studies are needed. The most spectacular process found on these rocks is landsliding. Between 100 and 150 landslides which exceed 10 m in scar length have been identified in the Park. They occur especially in the upper portions of drainage basins, where slopes are steepest, and are triggered by prolonged heavy rainfall due to the resultant rise in pore-water pressure, and perhaps by wind blowing down trees. Further work on infiltration, throughflow, permeability, water storage and weathering processes at different depths might help pinpoint the areas at greatest risk.

2.3.7.2 Melinau Limestone Formation. By far the most important process affecting the bare limestone is solution of calcium carbonate, with occasional redeposition as noted above. Water chemistry studies allow the general pattern of solution to be drawn, but further work is needed to provide a complete explanation of the observations. In particular, further study of organic solution processes and of the distribution of erosion within the limestone mass could be very productive here. A unique type of limestone erosion produces directed phytokarst in small areas of some of the cave entrances.

Physical erosion of limestone by rivers may be important in the production of foot caves but the limestones are very hard and careful experimentation will be needed to evaluate the relative importance of chemical and mechanical erosion. However, mechanical processes such as the collapse of limestone blocks from unsupported cliffs are considered to be very important when studying the morphogenetics of limestone slopes. Examples of the collapse of cave roofs are also known, and have been postulated as important in the evolution of such major features as the chasm between Gua Payau and Lubang Hijau.

2.3.7.3 Alluvial Plain. The fluvial processes acting here have been little studied. River channels alter frequently, especially due to damming by large logs: S. Melinau completely abandoned one channel in favour of another at Camp 5 during the expedition. Flooding of the alluvial plain areas can be rapid and complete, but the distribution of erosion and deposition during such events is not known. The situation may be rather precariously balanced, as is the base level of erosion during floods: caves normally acting as sinks for water from the plains have been known to act as resurgences at other times.

2.3.7.4 Setap Shale Formation and Belait Formation. No processes have been studied here.

2.3.8 Geomorphological evolution of the Park

2.3.8.1 Previous work provides a framework into which the evolution of the Park fits, but this will be modified by the results of further geomorphological work. Thus the Park has relevance to a large part of northwest Borneo although complications are introduced by localised tectonic movements along the Mulu Axis.

2.3.8.2 At present, it appears that erosion must have begun in the Mulu area during Pliocene times (up to 5 million years ago), following a late Miocene folding phase. This removed a Setap Shale cover from much of the Park and the position of the limestone gorges may have been determined by the drainage at that time.

2.3.8.3 In late Pliocene or early Pleistocene times there was considerable uplift of northwest Borneo which tilted the land to the northwest and rejuvenated erosional processes to the east, accompanied by deposition of sediments towards the coast. The high terrace remnants near the Brunei border of the Park are thought to date from this phase. Further uplift followed this and the Mulu Anticlinorium was subjected to upwarping, reflected by the cutting of the Tutuh gorge and probably also by the present height of G. Mulu, although the presence of more resistant beds in the Mulu Formation may also have contributed to this.

2.3.8.4 Substantial eustatic changes in sea level associated with the glacial phases in Polar regions have controlled the latest sequence of erosional and depositional phases now represented in the Park by terrace deposits and by erosion notches on limestone cliffs and in the caves. Ultimately, because they are extremely efficient sediment traps, the caves probably contain the most complete record now left of the geomorphological evolution of the Park and of any environmental changes which it has witnessed. Interdisciplinary speleological work will be needed to interpret this evidence, which is also of great regional scientific interest in the light it can be expected to throw on sea level and climatic changes in the Sunda Shelf area during the Pleistocene.

2.4 Hydrology *

2.4.1 Introduction. The Gunung Mulu National Park is drained in the south by tributaries of the S. Tutuh, notably the S. Melinau, and in the north by the S. Medalam and its tributary, the S. Mentawai. Hydrological studies during the Expedition focussed on the S. Melinau catchment, which drains an area of 100 square miles in the centre of the National Park before joining the S. Tutuh about a mile west of the Park boundary. A river flow gauging station was established at Long Pala and records were kept throughout the duration of the Expedition.

2.4.2 River discharge

2.4.2.1 River flows of the Melinau varied immensely during the period August 1978 (Table 7). Mean monthly flows varied by a factor of 10 between the peak months of November and December, 1977 (55.1 and 53.18 cumecs respectively), and the low flow months of September, 1977 (5.4 cumecs) and August, 1978 (5.0 cumecs). Daily flows varied by a factor of a 100 from over 169.9 cumecs during the floods of early November 1977 to only 1.6 cumecs on some days in September and October, 1977. Annual runoff over the year September, 1977 - August, 1978 totalled 3457 mm (136.1 ins).

2.4.2.2 An important management problem resulting from the massive fluctuations in discharge of the Melinau, particularly the low flows, is the restrictions placed upon boat transport within the Park area.

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* Account contributed by R.P.D. Walsh

Table 8 Chemical concentrations of river waters in the Mulu area

All concentrations are much lower at higher flows. Data from R.P.D. Walsh and M. Laverty.

Geology and Environment	Calcium Hardness ppm $CaCO_3$	Magnesium Hardness ppm $CaCO_3$	Soluble Silica ppm	Specific Conductance umhos	Total solutes and colloids mg/1
Streams of the Mulu Formation	0 - 9	1 - 9	6 - 9	9 - 25	40 - 45
Streams of the Limestone Formation	83 - 138	4 - 9	0.2 - 3	195 - 290	100 - 170
Streams composed of limestone water and sandstone streamwater passing underground through the limestone belt	30 - 78	2 - 18	2.5 - 10	80 - 180	55 - 125
Streams of the Alluvial Plain and Limestone Residuals (Berar, Pala & alluvial gullies)	70 - 80	9 - 13	2.5 - 3.0	150 - 175	105 - 120
All environments : the S. Melinau catchment (25,000 ha)	52 - 62	4 - 15	4½	120 - 145	83 - 100

2.5 Soils *

2.5.1 Soils of the Mulu Formation

2.5.1.1 On the Mulu Formation, the predominant slates and shales give rise to comparatively well developed soils, which show quite distinct altitudinal zonation. The main soils of the lower slopes are deep Red Yellow Podzolic and related Regosols. These are characterised by good profile drainage and little or no litter accumulation at the soil surface. Matrix colours are brown, red or yellow, and tend to get redder with depth. In the Park textures are generally fine, with loams in the topsoil giving way to clays or silty clays in the subsoils. In the well developed Red Yellow Podzolic soils there is a marked increase in redness, clay content and stone content with depth, although horizon boundaries are gradual rather than sharp. The Regosols are developed on recent colluvium and show much less marked colour or textural horizonation. The soils are fairly deep in the Park, often exceeding 1.5 m to the paralithic contact. These soils are intensively leached and have low pH values and base status.

2.5.1.2 As altitudes increase, surface organic layers become thicker, eventually grading into shallow peats. Beneath this organic layer, the upper mineral horizon is strongly gleyed, with white, grey or very pale yellow colours predominant. This surface gley horizon usually has a very sharp, and often wavy, lower boundary which is often marked by a more or less indurated thin iron pan. Beneath the boundary the profile appears to be well drained, and bright yellowish reds are the dominant matrix colours in the subsoil and underlying weathering rock. The taxonomic status of these

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* Account contributed by I. Baillie and C.P. Lim

soils is not yet finalised, but they will probably be classified as Gleys. The higher altitudes, surface peat layers increase further in thickness, and the soils qualify as true peats.

2.5.1.3 On the subordinate sandstones of the Mulu Formation, a similar altitudinal soil sequence is found. It differs mainly in the occurrence of a fairly narrow belt of weakly developed Humus Podzols inserted between the upper end of the Red Yellow Podzolic soils and the lower end of the Gleys. The soils seen were rather shallow and tending towards Lithosols, but just qualified for the weaker developed family of Humus Podzols.

2.5.1.4 It is not possible to give precise altitudinal limits for the main soil zones. This is partly because the boundaries are gradual and highly interdigitated. There is the added complication that the altitudinal zones tend to be depressed along the crests of spurs and ridges and elevated on flank slopes and in valley heads. For example, the Red Yellow Podzolic soils disappear at about 1000-1200 m on the main west ridge path, but are found as high as 1400 m on the steep flank slopes of the S. Tapin catchment. The soil boundaries therefore tend to run obliquely to the topographic contours. Peats are the dominant soils above 2000 m, but are found in poorly drained sites as low as 1300 m.

2.5.2 Soils of the Melinau Formation

The limestones of the Melinau Formation are very pure, and leave little residue for soil formation on weathering. The soils of the limestone mountains are therefore very shallow and discontinuous consisting of pockets of shallow, brown, humose, silty or clay loam, mixed with limestone gravel, in crevices between sharply angled limestone boulders and pinnacles. With such rudimentary soil development, there is little altitudinal zonation apparent. Organic matter appears to increase slightly in quantity and persistence above about 1000 m, but bare rock is still the predominant surface cover.

There are small pockets of slightly deeper reddish clay loams in places where the limestone contains significant ferruginous impurities. These soils are unique in the Park as they are of neutral reaction and high base saturation.

2.5.3 Soils of the Alluvium

2.5.3.1 The soils of the varied alluvial landscape that runs through from the Medalam to the Melinau are very diverse. The medium and high terraces are formed of quartzose and coarse-grained alluvium, and on the tops they carry extensive tracts of moderately and well developed Humus Podzols. In places the spodic horizons of these soils are so massive and impermeable that they impede surface drainage and have given rise to patches of wet peat, up to one metre in depth.

2.5.3.2 On the low terraces and floodplains there is a complex assemblage of imperfectly drained Alluvial and poorly drained Gley soils. The soils may vary considerably in texture over short distances, but are predominantly fine-textured. In some backswamp areas drainage is so poor that woody peats have developed, exceeding three metres in depth in places. There are also small areas of Humus Podzols on coarse-grained and well-drained alluvium but these are not as well-developed as those on the higher terraces.

2.5.3.3 This terrace and floodplain complex of soils is typical of other inland alluvial landscapes in Sarawak. A much less common feature of the alluvial belt of the Park is the occurrence of limestone towers and hills protruding up through the alluvium. The hills are very steep-sided and are practically devoid of soil cover.

2.5.4 Soils of the Setap Shale and Belait Formations

The main soils of the low but rugged ridge landscape on the outcrop of the Setap Shale and Belait Formation sediments in the west of the Park are Red Yellow Podzolics. These are typical of those found over large parts of Sarawak. They have yellowish brown topsoil colours which gradually redden with depth. The subsoils are also more blocky and compact and usually of noticeably finer texture than the surface horizons. The actual textures vary with the proportions of sandstone and shale in the parent material, but are predominantly fine — textured in this part of the Park. These soils are only moderately deep by humid tropical standards, with the paralithic contact often shallower than one metre. These soils are highly leached and acid, with pH in the topsoils ranging from 3.6 to 5.0 and about half a unit higher in the subsoils. Exchangeable base status is low. Apart from the Red Yellow Podzolics, the main soils of the western ridges are shallow Lithosols and deeper, but equally immature, Regosols. These are associated with steep and unstable slopes, particularly on the faces of the low, east-facing scarps.

2.6 Vegetation formations *

2.6.1 Introduction

2.6.1.1 The Park encompasses within its boundaries a quite remarkable diversity of vegetation, including all the major inland vegetation formations that occur in Sarawak, with the sole exception perhaps of vegetation on igneous-derived soils. The varied geology of the Park is the primary causal factor for this diversity, but this is compounded by a wide range in altitude resulting in a marked altitudinal variation in climate. These together influence the geomorphology, topography and soils - the habitat of the vegetation.

2.6.1.2 The land types (para 2.3.2 - 6; 8.1) can be conveniently used for an initial subdivision of the vegetation formations. Their boundaries are relatively discrete and coincide with those of major geological and vegetation formations. Furthermore they can be readily interpreted from aerial photographs. The land types and associated vegetation formations are given in Table 9 and their distribution shown on Map 5; the vegetation is described briefly below.

2.6.2 Gunung Mulu

2.6.2.1 The vegetation along the west ridge of Gunung Mulu has been investigated by P.J. Martin (1977) and the following account is based on his report, though his classification of the formations has been modified.

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* Account contributed by J.A.R.Anderson and P.P.K.Chai

Table 9 Main vegetation formations seen in Gunung Mulu National Park

Land type/altitude	Vegetation formation
1 Gunung Mulu sandstone/shales massif	
(i) Low altitude to 800 m	Mixed dipterocarp lowland forest
(ii) 800-1200 m altitude	Lower montane forest
(iii) 1200-1900 m altitude	Upper montane forest (tall facies)
(iv) 1600-2177 m altitude	Upper montane forest (short facies)
(v) 2177 - summit	Upper montane forest (summit facies)
2 Melinau Limestone	
(i) Scree slopes	Limestone scree forest
(ii) Cliffs	Limestone cliff vegetation
(iii) Slopes, low altitude to 800 m	Lowland limestone forest
(iv) 800-1200 m altitude	Lower montane limestone forest
(v) 1200 - summit	Upper montane limestone forest
(vi) Caves	Limestone cave vegetation
3 Alluvial plains	
(i) Alluvium	Alluvial forest
(ii) Quaternary terraces	Kerangas (tropical heath), forest
(iii) Peat swamps	Peat swamp forest
4 Setap shales /Mentawai drainage	
(i) Setap shale formation	Mixed dipterocarp lowland forest
(ii) Mentawai drainage	Kerangas (tropical heath) forest

The altitudinal zonation of the tropical rain forest formations is shown on Table 9.

This zonation is complex and though altitude itself is no doubt a primary factor the characters of the zonal vegetation formations, such as structure, physiognomy and even floristic composition, are much influenced by exposure, topography and soils. Forest on slopes, where soils are generally of greater depth, tends to be of greater height (often with some emergents), composed of larger trees, and to have a storied structure; whereas on the ridges a more even-canopied forest composed of mainly medium sized trees often occurs. This variation in the zonal formations is most marked at low and medium altitudes (it can also be readily interpreted from aerial photographs) but large-crowned high forest is to be found up to 1,800 m altitude. The overall effect is that montane formations project lower down exposed ridges.

2.6.2.2 Mixed dipterocarp lowland forest. This formation is typical of lowland rain forest of the region, but cannot be satisfactorily subdivided (as in West Malaysia) into lowland dipterocarp forest and hill dipterocarp forest. It occurs on the mainly steep dissected terrain on Gunung Mulu from low altitude to about 800 m where it abuts on, or merges into, lower montane forest. The boundary between these two formations is rarely precise.

The mature phase of this forest is multi-storied (Martin identifies four storeys) with an approximate maximum height of 55 m. Massive and cylindrical trees, often highly buttressed and exceeding 250 cm girth, dominate the upper canopy, in which the family Dipterocarpaceae predominates. Floristically the forest is extremely rich; 284 species of trees, exceeding

30 cm girth, were recorded in three sample plots, totalling 1.2 ha. The genera Shorea, Durio, Diospyros, Calophyllum, Garcinia, Eugenia and Xanthophyllum are particularly common. The most frequent species recorded were Dryobalanops beccarii and Shorea scaberrima at lower and Shorea obscura and Artocarpus lanceifolius at higher altitudes. The ground vegetation is somewhat sparse, though small palms (Licuala and Pinanga) are widespread; herbs are few and generally scattered becoming more common in the vicinity of small streams. The sedge Mapania cuspidata was recorded throughout the formation. Epiphytes are not conspicuous though sun-epiphytes in crowns of upper canopy trees are abundant. Large woody climbers, attaining the upper canopy are of frequent occurrence, and include many species of rattan. Bole climbers include the Lomariopsis and Teratophyllum ferns.

2.6.2.3 Lower montane forest On Mulu this is perhaps no more than a narrow transitional zone between lowland forest and upper montane forest, though it can be differentiated clearly from both these formations on general aspect and structure of the forest, and on floristic composition. The boundary between mixed dipterocarp forest and lower montane forest can be relatively sharp, as on the west ridge (the only locality where it has been intensively studied), but on slopes or flanks of the ridges, which often exceed 35 - 40 degrees, the transition from one formation to the next tends to be gradual.

Stratification of the mature phase of this forest is much less pronounced that in lowland rain forest; three strata are identified with a general maximum height of the top canopy of 30 m. Few trees exceed 180 cm girth and there is a pronounced increase in numbers of smaller trees, less than 180 cm girth. Buttressing is still very evident though the generel height of buttress is less than in lowland forest.

The forest continues to be floristically rich: in four plots totalling 0.5 ha 226 species of trees, exceeding 20 cm in girth were recorded, but of these only 34 attained more than 100 cm girth. Representation of the family Dipterocarpaceae is much less in this formation both with regard to size and number of trees and to number of species (nine species recorded of which five exceeded 100 cm girth, but at higher elevations only one species, Shorea monticola, occurs). The families Fagaceae, Guttiferae and Myrtaceae provide the principal dominants at lower elevations in the formation, especially the first mentioned, where the Flacourtiaceae and Sapotaceae become important at higher levels. Quercus subsericea is the most common large tree in the lower part of the formation, and this species as well as Calophyllum nodosum, Garcinia dulcis, Eugenia caudatilimba, E. lineata and Timonius askerianus may be considered typical of the formation as a whole.

The palm flora is relatively rich and includes small rattans; Pinanga salicifolia is characteristic of this transitional forest.

A significant feature of the forest, very evident when walking through it is the increase in the herbaceous flora. Argostemma brachyanthus, Neckia serrata, Begonia spp., and two species of Gesneriaceae (Loxocarpus and Cyrtandra) are of frequent occurrence. At higher elevations two species of Somerila make their appearance. Bryophytes and their associated fern epiphytes become increasingly evident, but large climbers are almost totally lacking.

2.6.2.3 Upper montane forest (tall facies) At about 1,200 m on the west ridge of the mountain there is a marked change in the aspect of the forest.

The soils are peaty and damp and covered in a thick layer of moss. Bryophytes and lichens also encrust the lower stems of the trees and drape from the crowns. This general air of dampness is probably related to the normal level of cloud development on the mountain and marks the lower limits of true montane or mossy forest. This vegetation formation extends up to 1,900 m but at higher levels it overlaps with a short facies (2.6.2.4) and is only found in the more sheltered localities.

The forest is mainly dense and difficult to penetrate, being composed of small trees few of which exceed 120 cm girth, though forest with larger trees and a higher canopy occurs on some slopes especially those with a southern aspect. No precise stratification is evident and the main canopy does not normally exceed 15 m in height though some emergents may attain 21 m. Many trees are of poor form being bent or crooked. Buttressing is uncommon, though stilt-rooting, usually partially or completely hidden by bryophytes, is common. Small ferns of the family Grammitidaceae are common.

There is a further decrease in the arboreal flora: 155 species of trees over 10 cm girth were recorded in five plots totalling 0.365 ha; of these only 38 species attained a girth of 60 cm. The families Guttiferae and Myrtaceae are particularly well represented throughout this formation. Widespread and common species include Calophyllum teysmannii var. inophylloide, Eugenia palembanica and Prunus arborea var. stipulacea. A notable feature also is the frequent occurrence of the two conifers, Dacrydium beccarri and Phyllocladus hypophyllus.

Shrubs and shrublets growing on the bryophyte covered peaty surface are conspicuous, especially those in the families Ericaceae, (Rhododendron lanceolatum and R. crassifolium are particularly common) Gesneriaceae, Melastomataceae and Rubiaceae. The herbaceous flora is also well represented including aroids, begonias, pitcher plants, orchids and gingers. Epiphytes are numerous on the bryophyte covered stems and crowns of trees. Though large climbers are mainly absent a notable feature of the formation is the abundance of the attractive scrambling bamboo, Racemobambos glabra. The two palmlets, Pinanga pilosa and P. keahi, are conspicuous features of the montane forest; rattans are rather scarce.

2.6.2.4 Upper montane forest (short facies) The lower limit of this facies is approximately 1,600 m and it overlaps with tall facies for about 300 m up to 1,900 m. At lower levels in the over-lapping zone the short facies is largely confined to exposed ridges.

The forest comprises a dense mass of small stunted trees, usually with conspicuous bends and growing at various angles to the vertical. This latter feature is particularly noticeable on slopes at higher altitudes. Near the ground there is often a dense layer of moss-covered tree stems, some of medium-size or large girth, growing horizontally and producing numerous small sucker shoots. The small crowns tend to be wedged into a single canopy stratum which usually varies between 5 and 9 m in height, though sporadic emergent trees with spreading crowns may attain a height of 13 m.

Two floristic associations are recognised: the first and lower association is dominated by trees of the Fagaceae, Podocarpaceae and

Myrtaceae. At higher elevation the other association predominates, composed of the last two mentioned families, together with the Ericaceae and Guttiferae. There is no precise boundary between the associations and at lower altitude their distribution appears to be related to site; the first association being confined to ridges whilst the second occurs on slopes. Above 2,050 m the latter is more widespread, both on ridges and slopes. In the lower zone, Lithocarpus hatusimae and the two conifers, Dacrydium beccarii and Phyllocladus hypophyllus, are the principal dominants whereas at higher altitudes in addition to the conifers, Calophyllum garcinioides and Eugenia kinabaluense are the larger trees.

The family Ericaceae is particularly well represented in the small-tree and shrub layer, including Diplycosia (5 spp.), Rhododendron (4) and Vaccinium (4). Other notable and widespread species are Elaeocarpus congestifolius, Drimys piperita, and Plethiandra hookeri. Scrambling plants are abundant, including Hederella quintuplinervis, Embelia spp. and three conspicuous pitcher plants (Nepenthes lowii, N. muluensis which is a Mulu endemic, and N. tentaculata). Herbs (mainly Sonerila spp. and orchids) are generally poorly represented in upper montane forest; thick tussocks of the sedge Gahnia borneensis are common in open localities. Here also terrestrial ferns (e.g. Coryphopteris, Araiostegia) occur, including two small tree-ferns (Cyathea polypoda and C. ramispina). The principal epiphytes are orchids and small ericaceous shrubs. Large woody climbers are absent, though the occasional scrambling rotan (Calamus javensis and C. divaricatus) is encountered.

2.6.2.5 Summit zone. The vegetation on much of the summit zone, covering perhaps the highest 200 m on the mountain, is disturbed as a result of the establishment some years' previously of a survey trigonometrical point. The soil is peaty and has been weathered into mounds or hummocks which in places are totally exposed.

There occurs a stunted facies of mountain forest on the actual summit plateau, which covers a few hectares in area. The dense shrubby vegetation varies in height between about 0.5 and 3 m , with a few larger stunted trees, mainly of the species Dacrydium beccarii and Leptospermum flavescens, attaining a height of 5m. The flora of this zone is basically similar to that of upper montane forest; of the twenty-six species of trees and shrubs recorded eight belong to the family Ericaceae. The herbaceous vegetation comprises only four terrestrial orchids (Appendicula, Coelogyne, Dendrochilum, Eria) and the sedge Gahnia borneensis. This latter species, a fern (Dipteris novo-guineensis) and the common lycopod (Lycopodium cernuum) tend to colonise the bare soil surface.

2.6.3.1 Melinau Limestone. Vegetation on limestone is distinctive and contains numerous calcicolous species that are endemic to limestone. The land sub-types (see para. 8.1) provide a diversity of readily identifiable habitats each supporting a characteristic vegetation and flora. These are used as a basis for the description of the vegetation:

(i) Scree slopes: (limestone scree forest).
(ii) Cliffs: (limestone cliff vegetation).
(iii) Slopes: low altitude to 800 m (lowland limestone forest).
(iv) Lower montane: 800 - 1,200 m (lower montane limestone forest).

(v) Montane: 1,200 m to summit (upper montane limestone forest).

(vi) Caves: (limestone cave vegetation).

<u>2.6.3.2 Scree slopes</u>. The forest on the generally steep, boulder-strewn scree slopes is mostly somewhat open with few, widely spaced trees. It is dominated by massive emergents which occasionally may exceed 5 m girth and 50 m in height. Emergent species include <u>Azadirachta excelsa</u>, <u>Sindora coriacea</u> and <u>Scorodocarpus borneensis</u>. <u>Eusideroxylon zwagerii</u> and <u>Pometia pinnata</u> also are common dominants though they rarely attain great height. In the middle and lower storeys <u>Diospyros cauliflora</u>, <u>Teijsmanniodendron pteropodum</u>, <u>Paranephelium nitidum</u> and <u>Baccaurea lanceolata</u> are common. <u>Popowia pisocarpa</u> and <u>Mammea anastomosans</u> are typical and widespread species of the understorey.

The screes themselves, with sharply eroded limestone rocks and boulders and mainly damp calcareous soils, provide a wide range of minor habitats and niches which support a rich shrub and herbaceous flora. Typical shrubs include <u>Lunasia amara</u>, <u>Mycetia javanica</u> and <u>Acranthera involucrata</u>. Species of Urticaceae, especially <u>Elatostemma</u>, are abundant and in many places carpet the forest floor. A typical species of damper localities is <u>Chloranthus officinalis</u> whereas on the limestone rocks and boulders <u>Antrophyum parvulum</u> and Gesneriaceae species, particularly <u>Monophyllaea</u> spp. are very evident.

<u>2.6.3.3 Cliffs</u>. The immense limestone cliffs, fully exposed to the tropical sun and generally lacking in any soil or moisture provide an extreme habitat for plant growth. Shrubs and even small trees root on the ledges and sills and in the crevices and niches of the limestone. This is the typical habitat of the genus <u>Boea</u> of the Gesneriaceae, and at least

five species have been recorded on the Melinau limestone. Other species include Ficus tinctoria var. gibbosa and Fagraea auriculata spp. borneensis which more usually occur as epiphytes. In full sun, often cascading for 5-6m is Phanerosorus sarmentosa, and smaller fern lithophytes (e.g. Taenitis cordata, Adiantum malesicum) are found in more shady spots; and at the cliff base, Hypodematium crenatum.

At lower levels where the cliffs are less exposed and in sheltered ravines the cliff walls are often draped in a heavy cover of herbs. This is the typical habitat of many calcicolous Gesneriaceae, particularly of the genus Monophyllaea (M. johannis -- winkleri, M. beccarii and M. horsfieldii). Species of the related genus Cyrtandra also occur here. This is also the habitat of an extraordinary calcicolous palm (Salacca rupicola Dransf.),abundant in the Park and known nowhere else.

2.6.3.4. Slopes. On the very steep limestone slopes with gradients exceeding 45 degrees a dense forest of small trees and shrubs occurs, but on more moderate slopes, gradients usually 35-45 degrees, high forest is found. The latter has only been studied on Gunong Api in the vicinity of the Melinau Gorge.

At low altitude, up to about 800 m, the forest is moderately dense, dominated by large emergent trees that may attain a height of 40m and exceed 250 cm girth. The principal species are mainly dipterocarps, including Hopea dasyrachis, Hopea andersonii ssp. andersonii and Shorea multiflora; also the non-dipterocarps, Brownlowia glabrata and Palaquium sericeum. Stratification of the forest is not readily evident but of the medium-sized and small trees Harpullia arborea, Drypetes microphylla, Cleistanthus myrianthus and Chisocheton beccarianus are of frequent occurrence. Chaetocarpus castanocarpus and Rinorea horneri are common species of the understorey. Larger trees tend to be heavily buttressed.

The shrub layer is very sparse but includes two species of Acanthaceae: Hallieracantha caudata and Borneacanthus grandifolius. The deep litter layer is mainly bare and the herbaceous flora very sparse, except on exposed limestone rocks. Large woody climbers (Phanera, Rourea, and Derris) occur but are less evident than in mixed dipterocarp forest. Shade epiphytes are not abundant. Rattans are very rare; a hairy form of Calamus javensis being the only one recorded for Mulu limestone.

2.6.3.5 Lower montane limestone forest. As on Gunung Mulu, with increasing altitude the height of the canopy and the average size of trees tends to decrease; there is also a similar decrease in the representation of the dipterocarps. Lower montane limestone forest is considered to start at the 800 m level though between this and the high forest at lower altitude there is no distinct boundary.

The terrain is generally steeper and more rugged with large limestone blocks, some 5 - 10 m in height, and intervening small ravines. The forest is dense and is composed of small trees, of which few exceed 150 cm girth. The canopy height is less than 25 m. Dipterocarps (with the exception of Hopea argentea) are absent and the forest is mainly composed of non-calcicolous species such as Parishia maingayi, which is very abundant, Canthium didymum, Melanorrhoea inappendiculata, Palaquium rostratum, and Tristania obovata. Trees tend to be of poor form and are often bent and leaning.

The rather light canopy permits a somewhat luxuriant growth at ground level. Typical calcicolous species (mainly in the families Gesneriaceae and Urticaceae) occur on the exposed limestone rocks. Herbs and shrubs growing on the deep litter layer include *Ardisia* sp., *Argostemma* sp., *Begonia conipila* and *Medinilla* spp. Large woody climbers are absent, but epiphytes, mainly orchids, ferns and aroids, drape the lower stems of trees.

2.6.3.5 Upper montane limestone forest. On Gunung Api this formation begins at approximately the same altitude (1,200 m) as on Gunung Mulu. Again the main obvious feature is the abundance of bryophytes that cover the deep humus layer on the ground and drape from the largely scrub forest. As on Gunung Mulu there are several facies of different stature and floristic composition.

The nature of the exceedingly broken terrain does not permit the development of forest with a consistent canopy. Small trees of poor form are interspersed with shrubs, and in places bare limestone rock is exposed. On the deep humus layer calcicolous plants give way to calcifuges and the principal species are the same as those found on Gunung Mulu at the same or somewhat higher altitude, including the two conifers *Dacrydium beccarii* and *Phyllocladus hypophyllus*, as well as *Eugenia bankensis*, *Eugenia tetraptera* and *Palaquium gutta*; and amongst the shrubs *Rhododendron micro-maleyanum* and *Ficus deltoidea* var. *borneensis*. Pandans are particularly abundant and at least three species (*Pandanus calcinactus*, *P. pectinatus*, and *P. pumilus*) occur here; the extensive areas of almost pure *Pandanus*, may be on areas hitherto cleared by fire. The large pitcher plant, Nepenthes stenophylla, is conspicuous in more open localities.

At higher altitude, about 1,520 m, the low, open forest on the ridge is reported to be dominated by Leptospermum flavescens, together with Dacrydium and Phyllocladus. A Casuarina species (probably C. sumatrana) also occurs here and in the understorey of shrubs two rhododendrons (R. himantodes and R. ericoides) are common. Large myrmecophytes are frequent on the Leptospermum trunks. Deep clefts in the rock maintain a sparse but interesting moss flora.

On the flat plateau that forms the lower summit of Gunung Api at 1,580 m the vegetation consists of a low carpet (less than 1 m in height) of shrubs, orchids and pandans, including three species of Rhododendron, a Melastoma, and a Schima.

2.6.3.6 Limestone caves. The limestone caves contain a limited and probably highly specialized flora of non-vascular plants, especially algae, which need further investigation.

2.6.4 Alluvial Plain

2.6.4.1 The vegetation formations on the alluvial plain north and west of the limestone mountains of Gunung Api and Benarat are diverse and complex, for not only do they include the varied vegetation on the alluvium itself but also the kerangas forest on the Quaternary terraces and in addition one small localized area of peat swamp forest.

2.6.4.2 Alluvial forest This vegetation formation developed on alluvium, is perhaps the most complex within the Park. It mirrors the great variation in the soil types already described. The most widespread variation is that on gley soils occuring mainly in the flood plain of the Melinau and Melinau Paku rivers. The forest is not excessively dense and uneven canopy tends to be rather open. Large emergents may attain a height of 30-40 m and maximum girths of larger trees range between 150 and 200 cm, though a few larger trees, especially Eusideroxylon melagangai, may exceed 250 cm. This is a characteristic species of the formation. It is widespread, though in any one locality it is rarely abundant. Other common upper storey species include Parashorea macrophylla, Pometia pinnata, Octomeles sumatrana, Dracontomelon dao, Shorea seminis, Pterospermum subpeltatum and Pentaspadon motleyi. In addition Bhesa paniculata, Paranephelium sp. and Polyalthia hookeriana are characteristic species of the middle and lower storeys. Large trees tend to be heavily buttressed; some stilt-rooting is also present.

The rather open canopy permits the development of a generally luxuriant growth on the forest floor. Small palms (Licuala, Iguanura, Pinanga) are of frequent occurrence. Gingers (Globba, Kaempferia, Achasma, Plagiostachys) are widespread and locally abundant.

Both large woody climbers, including rattans (especially Korthalsia macrocarpa, Ceratolobus discolor, Daemonorops sparsiflora and many species of Calamus) and small root climbers are common. Epiphytes at low level are often conspicuous, including species of Poikilospermum, Medinilla and Freycinetia. In more open areas, particularly near rivers, the climbing ferns Teratophyllum, Lomagramma and Lomariopsis species may completely cover the lower stems of trees.

There is some evidence in very localized areas of previous cultivation in this vegetation formation, but the consequent secondary forest has now developed to a state whereby it is almost indistinguishable from

Shorea albida is the principal dominant and most characteristic species of this formation. It is also the main dominant in peat swamp forest and consequently the two formations are difficult to differentiate by aerial photographic interpretation.

On the large terraces west of Gunung Benarat Shorea albida is very abundant. On the perimeter of the terrace it may attain large size (exceeding 250 cm girth) and be emergent. Other upper canopy species include Melanorrhoea macrocarpa, Calophyllum havilandii, Calophyllum garcinioides, Cotylelobium burkii, and Shorea scabrida. Towards the centre of the terrace a kerangas forest of the Kerapah type occurs on shallow peat (about 100 cm in depth). The principal dominants, in addition to Shorea albida, are Melanorrhoea beccarii and Dactylocladus stenostachys. Lophopetalum rigidum and Payena sp. are very abundant in the lower storey. Two pitcher plants, Nepenthes bicalcarata and N. rafflesiana, are a conspicuous feature of the ground vegetation.

On the large terrace immediately north of Gunung Benarat the peripheral forest type on the terrace itself is similar to the first type described above. In the centre of the terrace a low Kerapah type forest occurs on shallow peat (120 cm in depth) where drainage is apparently impeded. The small trees, few exceed 100 cm girth, are closely spaced and the forest very dense. The principal species are Shorea albida, Calophyllum retusum, Tristania obovata, and Cratoxylum glaucum. The base of trees is heavily moss covered and bears numerous epiphytes.

Towards the northern margin of the terrace the forest reverts to a high kerangas type in which the principal dominants in addition to Shorea albida are Casuarina nobilis and Agathis borneensis.

On the sloping margins of the terraces the forest is basically similar to that found in mixed dipterocarp forest. The main dominants are dipterocarps, including Dipterocarpus lowii, D. borneensis, Shorea primary forest. Belian (Eusideroxylon melagangai) produces a durable and much sought-after constructional timber. In relatively accessible forest in the lower reaches of the Melinau and Melinau Paku rivers many trees of this species have been felled and the timber removed. The trees usually coppice thereafter producing a number of sturdy shoots which develop into small or medium-sized trees.

On terrace remnants and shallow peat overlying alluvium a more acidophilous vegetation is present, with many species more characteristic of either kerangas or peat swamp forest. Some freshwater swamp forest, on shallow peat subject to periodic flooding, occurs in the drainage of the Terikan river. The principal dominant is Alstonia pneumatophora, which may attain massive size. Other large trees in this locality include Anisoptera marginata, Shorea teysmanniana, Shorea platycarpa, Jackia ornata and Blumeodendron tokbrai.

2.6.4.3 Kerangas forest on Quaternary terraces

This formation tends to be very variable, dependent mainly on the physical and chemical properties of the soil and on drainage conditions. The forest is mainly composed of medium-sized or small trees, few of which exceed 200 cm girth, and has a generally even canopy. The trees are mainly straight with a pole-like appearance, often giving the impression of a medium-aged plantation. The understorey tends to be moderately dense, composed largely of saplings and poles of the tree species, as well as some palms, pandans, pitcher plants and a few shrub species. The herbaceous flora is sparse. Epiphytes at low level are frequent and the basal parts of tree boles are usually covered in moss to a height of about 1.5 - 2 m. Large woody climbers are generally absent though small and medium-sized climbers are of occasional occurrence. The rattan flora is restricted and consists of species peculiar to this forest type.

ochracea, and S. parvifolia. The small palms, Licuala borneensis and Areca minuta, are particularly abundant in the understorey.

2.6.4.4 Peat swamp forest. The small peat swamp forest situated between the Tarikan and Medalam rivers and covering no more than about 180 ha is of interest in that it shows in a very restricted area some of the typical features found in the vast coastal swamp forests of Sarawak. There is a concentric zonation of four forest types which from the perimeter to the centre form a catenary sequence related, in all probability, to the decreasing fertility of the peat soils. This is reflected in the structure of the forest, in a marked decrease in the average size of all trees and of trees of individual species, and in changes in the general floristic composition of the forest. Mixed high forest in the peripheral zone, with an uneven canopy height of about 32m, is succeeded by an increasingly dense forest, with an even canopy height of about 20m, composed of numerous small trees of fewer species; and finally in the central zone by a low open forest in which the small trees usually do not exceed 10m in height and generally exhibit some degree of stunting. Brief descriptions of the four forest types follow :

Type 1. Occurs in the peripheral zone particularly near the Medalam river. The forest is multi-storied with an irregular and uneven canopy about 32m in height and moderately dense middle and lower storeys. Principal dominants which may exceed 200 cm in girth are Shorea albida, Melanorrhoea beccarii, Melanorrhoea macrocarpa, Calophyllum retusum, Combretocarpus rotundatus, Dryobalanops rappa, Shorea platycarpa, Copaifera palustris, and Dactylocladus stenostachys. Lophopetalum rigidum is abundant in the lower storey. A shrub layer is virtually absent and

and herbs sparse. Large woody climbers and small root-climbers are occasional.

Type 2. Tall pole-like forest, resembling that in kerangas forest, with a generally even though broken canopy at a height of about 28 m. The main species of the upper storey are Calophyllum retusum, Palaquium cochleariifolium, Shorea albida, Litsea crassifolium and Dactylocladus stenostachys. The middle storey is somewhat sparse but the lower storey tends to be dense. Pandanus andersonii is widespread and forms dense thickets. Large climbers are virtually absent and epiphytes few. The litter layer covers a mass of rootlets which tends to form a partial 'platform' above the true swamp surface.

Type 3. Similar to Type 2 with largely the same floristic composition, but forest denser being composed of numerous small trees (few exceed 90 cm girth) with a canopy height of about 19 m. A compacted surface-root layer is overlain by litter; pandans and other shrubs sparse.

Type 4. Open forest with groups of small trees, mainly less than 60 cm girth and 10 m in height, with a few larger trees of Combretocarpus rotundatus. Most trees exhibit some degree of stunting. Surface peat is exposed in places; two pandans (Pandanus andersonii and P. motleyanus) and Thorachostachyum bancanum are of scattered occurrence. Epiphytes (orchids, Dischidia, Dendrotrophe) are frequent; base of stems of trees, and tree stumps are moss covered.

2.6.5 Setap Shale Formation and Mentawai drainage

2.6.5.1 This land type forms a relatively well-defined unit in the north western part of the Park. It may be subdivided by taking the land on the

Setap Shale Formation itself as one unit and the remainder of the Mentawai drainage as another.

2.6.5.2 Setap Shale Formation. The vegetation on the Setap Shale Formation may be all classed as mixed dipterocarp forest but as on Gunung Mulu there is considerable variation: on the main watershed between the Mentawai and Melinau rivers typical mixed dipterocarp forest occurs, but to the north on highly dissected terrain the mixed dipterocarp forest is mainly composed of smaller trees. On aerial photographs this resembles kerangas forest though it should not be classed as such.

The forest on the main ridge which forms the watershed between the Berar river and tributaries of the Mentawai river is similar in structure to the mixed dipterocarp forest at low altitude on Gunung Mulu though the floristic composition is markedly different. Also overall the trees tend to be smaller in size - few exceed 200 cm in girth - and the top canopy height lower, maximum height usually less than 50 m. the main dominants are Shorea (S. virescens, S. ovalis, S. beccariana and S. maxwelliana). Other dipterocarps include Dryobalanops beccarii and Parashorea smythiesii. In the middle storey Elateriospermum tapos is of frequent occurrence, and in the lower storey the Myristicaceae (Gymnacranthera, Horsfieldia and Knema) and Diospyros species are particularly well represented. The large spiny palm Oncosperma horridum occurs on steep slopes, and the understorey has a particularly rich and varied palm flora including species of Licuala, Pinanga and Salacca.

On the apparently less fertile soils, often with a 'mor' layer, to the north the mixed dipterocarp forest is composed of generally smaller trees and the top canopy height is usually lower, about 40 - 45 m. Common dominants in this forest are Shorea argentifolia, S. ochracea, Dipterocarpus caudiferus, Tetramerista glabra and Tristania whiteana. Here also palms, including rattans, are very numerous.

2.6.5.3 Mentawai drainage The extensive high terraces in the Mentawai drainage are entirely covered in kerangas forest, which also occurs on the Belait Formation towards the Brunei border. The basic structure, density and floristic composition of the kerangas on the dissected high terraces here are somewhat different from that found on the flat low terraces further south and east (para 2.6.4.3). In localized areas on lower terrace margins the structure of the forest resembles that in mixed dipterocarp forest and the arboreal flora is rich, but on the terraces themselves the trees are usually medium-sized or small (few exceeding 150 cm girth) and the height of the uneven canopy usually less than 30 m with some emergents up to 40 m. Typical species of the upper storey are Dipterocarpus lowii, Shorea venulosa, S. acuta, S. ovata, Melanorrhoea macrocarpa and Casuarina sumatrana. Shorea albida, the principal dominant on low terraces, is very rare. Common species in the middle and lower storeys include Myristica lowiana, Whiteodendron moultonianum, Ashtonia excelsa, Santiria laevigata and Hopea vaccinifolia. The wild sago palm or pantu (Eugeissona utilis) occurs on some terraces and on the narrow ridges leading to the terraces. The shrub layer is usually rich in other palms and pandans. Here also in localized areas Agrostistachys longifolia and Euthemis minor are abundant.

2.7 The significance of the flora

2.7.1 General Tropical rain forest that clothes the whole island of Borneo contains one of the richest floras in the world. There is some evidence to indicate that the northern part of the island, comprising the Malaysian states of Sarawak and Sabah, as well as Brunei and the Indonesian province of Kalimantan Barat, is especially rich in species. This may be in part due to evolutionary and plant geographical trends, but is also related to the diversity of habitats consequent of the variation in geology and land types. Within the Gunung Mulu National Park, the remarkable diversity of vegetation types (see para 2.6) supports perhaps one of the richest assemblages of species to be found in any area of comparable size. Present knowledge of the flora of the Park is nevertheless incomplete, and much further research, in particular intensive collecting by specialists, is required to obtain a fuller understanding.

2.7.2 Flowering plants •

2.7.2.1 Five Gymnosperm trees occur in the Park: the stately lowland form of Agathis borneensis is found locally on terrace formations (in association with Casuarina nobile); the other three conifers occur in montane forest and include two species of Dacrydium (D. beccarii and D. xanthandrum) and the interesting Phyllocladus hypophyllus. Six species of the Gymnosperm Gnetum have been recorded. These are all small climbers with the exception of G. gnemon var. tenerum, a small treelet found in mixed dipterocarp forest.

• Data contributed by J.A.R. Anderson and P. Chai

2.7.2.2 At low to medium altitude the family Dipterocarpaceae, as may be expected, provides the principal forest dominants. This family is well represented in the Park with eight genera (the only Bornean genus not yet recorded is the monospecific Upuna) and 115 species, which approaches half the total number of species (235) that is known to occur in Sarawak. In the magnificent forests on the lower slopes of Gunung Mulu, massive dominants of the genera Shorea (particularly S. ferruginea, S. quadrinervis, and S. scaberrima) and Dryobalanops (D. beccarii) are evident. The occurrence of the family decreases with altitude, and in the montane forest the only representative is Shorea monticola. In alluvial forest the family is less common, though the large-leaved Parashorea macrophylla is conspicuous in this vegetation type, and also less frequently Dipterocarpus apterus. At low altitude on limestone the genus Shorea is poorly represented, but three species of Hopea (H. andersonii, H. dasyrrhachis, and H. argentea) are amongst the largest and most conspicuous of the dominants. In kerangas forest on the Quaternary terraces Shorea albida is the most abundant dominant: also in peat swamp forest where it is locally gregarious forming a pure canopy. Further intensive collecting, especially when a general flowering and fruiting of the dipterocarps occurs, will surely reveal many additional species, particularly in the genera Hopea and Vatica.

2.7.2.3 The floristic wealth and complexity of the lowland forest is also reflected in the other principal arboreal families. In the Euphorbiaceae, for instance, 30 genera and 87 species have been recorded. Other important and widespread families include the Annonaceae (14 genera 33 species), Anacardiaceae (13/20), Guttiferae (5/48), Lauraceae (12/63) Myristicaceae (4/27), Myrtaceae (7/67), Meliaceae (7/35) and Sapotaceae

(8/25). The lowland forests of the Park must in the future provide one of the principal reservoirs of genetical resources of tropical trees in the region.

2.7.2.4 In lower montane forest on Gunung Mulu, the oaks (*Quercus* and the closely related genus *Lithocarpus*) and chestnuts (*Castanopsis*) predominate. 29 species of the family Fagaceae have been recorded. The Guttiferae (mainly *Garcinia*) and Myrtaceae (*Eugenia*, *Leptospermum* *Rhodamnia*, *Tristania* and *Xanthomyrtus*) are also well represented. In upper montane forest on the higher ridges, the family Ericaceae is prominent, including some beautiful species in the genera *Rhododendron*, *Diplycosia* and *Vaccinium*. The flora here has marked affinities with that on Gunung Kinabalu. It covers, however, a very restricted area, and severe disturbance could greatly affect the ecology and result in the elimination of some species.

2.7.2.5 The limestone mountains of Gunung Api and G. Benarat are unique, rising to a height of over 1500 m (5000 ft) from the flat alluvial plain which is only approximately 120m above sea level. The flora is of exceptional interest and, as might be expected, is markedly different from that on non-calcareous soils. Limestone endemics are numerous, and the height and isolation of the mountains contribute to the likelihood of discovering an appreciable number of species new to science. The limestone walls, cliffs, and overhangs are the habitat, *par excellence*, of the remarkable genus *Monophyllaea* (Gesneriaceae). In a recent revision of the genus by Mr B.L. Burtt (1978), seven of the eight species occurring on the Melinau limestone are newly described, and as far as is known are confined to this locality. In addition three endemic *Cyrtandra* species in the same family have recently been described, and a total of at least 30 species in 9 genera occur in the Park itself. The flora at high altitudes (above 1200 m) is likely to prove of exceptional interest, as no limestone of similar altitude is to be found between north Sumatra and New Guinea.

2.7.2.6 The great variety of habitats support a rich and abundant flora of climbers and epiphytes. Fig species, in the form of trees, shrubs, epiphytes, climbers, stranglers and banyans, are widespread, occuring in all vegetation types. 27 species have been recorded, though with further and more extensive collecting, the total may well exceed 80. Representatives of all the main genera of climbers in other dicotyledonous familes, such as the Connaraceae, Leguminosae, Convolvulaceae, Melastomataceae, Piperaceae and Rubiaceae, are present. Pitcher plants (Nepenthes spp.) arouse curiosity (and require special protection from tourists; see 8.4.2.2) Ten species have been recorded in the Park. At higher altitudes on Gunung Mulu, N. lowii, N. tentaculata and N. muluensis (a recently described endemic species) often form dense thickets, whereas on Gunung Api above 1200 m, N. stenophylla is abundant. On the infertile and acid peat and kerangas soils the characteristic species are N. ampullaria, N. bicalcarata, N. gracilis, and N. rafflesiana. The rare and localized N. veitchii has been recorded on the Melinau terraces.

2.7.2.7 Though the famous Rafflesia has not been recorded in the Park, a species of the related genus Rhizanthes occurs as a root parasite on alluvial soils near the Melinau Gorge and on a sandstone ridge leading to Hulu Air Jernih. An attractive small Balanophora (B. elongata)is to be found in mixed dipterocarp forest on the lower slopes of Gunung Mulu, and a second species occurs at higher altitudes, almost to the summit, on the same mountain.

Parasitic and semiparasitic Loranthaceae are of frequent occurrence: 13 species in 10 genera have been recorded. In addition to the saprophytic orchids which have not yet been studied, three species of the saprophytic Burmannia occur in montane forest and in kerangas on terraces, whereas the interesting and rare small saprophyte Cotylanthera tenuis has been collected on the mid-slopes of Gunung Api.

2.7.2.8 Amongst the larger and more abundant monocotyledons, the palms are pre-eminent. About 109 species in 20 genera have been recorded by Dr. J. Dransfield, who has made an intensive study of them in limited areas of the Park. He considers that the Park on an area basis must be one of the richest areas in the world for palms. Of the larger species, the wild sago palm, Eugeissona utilis, the staple diet of the nomadic Penan, occurs on the steep ridges of Gunung Mulu and on the margins of Quaternary terraces. Attractive small palms of the genera Pinanga and Licuala are abundant, especially on alluvium, the margin of terraces and in the Mentawai drainage. Recent described endemics from the alluvium are Iguanura melinauensis and and Licuala lanata and from the limestone Calamus neilsonii and Salacca rupicola. The massive, spiny, new Salacca magnifica, only known previously from the Hose mountains, occurs on the Setap Shales in the Mentawai drainage as does an endemic Areca (A. abdulrahmanii). The second species of Pogonotium (P. divaricatum) is described from the kerangas. Rattans are particularly numerous and diverse, occurring in all vegetation types, even in upper montane forest on Gunung Mulu.

2.7.2.9 The extensive alluvial forest at the base of the limestone mountains and hills contains a rich herbaceous flora in which aroids, gingers and herbaceous species of the Urticaceae are particularly numerous. This vegetation type is of especial importance; not only does it contain a wealth of

Table 10 Numbers of genera and species of flowering plants identified in Gunung Mulu National Park.
Arranged in alphabetical order of family

Family	Numbers Gen.	Numbers Spp.	Family	Numbers Gen.	Numbers Spp.
Gymnosperms			Total	5	11
Araucariaceae	1	1			
Podocarpaceae	3	4			
Gnetaceae	1	6			
Angiosperms			Total	496	1518
Monocotyledons			Total	74	192
Apostaceaceae	1	1	Maranthaceae	3	3
Araceae	9	12	Musaceae	1	1
Burmanniaceae	1	2	Orchidaceae	9	10
Commelinaceae	1	1	Palmae	20	109
Cyperaceae	7	11	Pandanaceae	2	19
Flagellareaceae	2	2	Taccaceae	1	1
Gramineae	4	5	Triuridaceae	1	1
Liliaceae	3	5	Zingiberaceae	7	9
Dicotyledons			Total	422	1326
Acanthaceae	5	8	Chloranthaceae	1	1
Alangiaceae	1	4	Clethraceae	1	1
Amaranthaceae	1	1	Combretaceae	1	2
Anacardiaceae	13	20	Compositae	2	2
Annonaceae	14	33	Connaraceae	3	4
Apocynaceae	7	8	Convolvulaceae	2	3
Aquifoliaceae	1	7	Cornaceae	1	3
Araliaceae	4	12	Crypteroniaceae	1	1
Aristolochiaceae	1	1	Cucurbitaceae	1	1
Asclepiadaceae	1	1	Cunoniaceae	1	1
Balanophoraceae	1	2	Daphniphyllaceae	1	1
Balsaminaceae	1	1	Datiscaceae	1	1
Begoniaceae	1	4	Dilleniaceae	1	3
Bignoniaceae	2	4	Dipterocarpaceae	8	115
Bombacaceae	3	9	Ebenaceae	1	17
Burseraceae	3	17	Elaeocarpaceae	1	23
Campanulaceae	2	5	Ericaceae	5	39
Capparidaceae	1	1	Erythroxyllaceae	1	1
Casuarinaceae	1	1	Escalloniaceae	1	5
Celastraceae	8	11	Euphorbiaceae	30	87

Fagaceae	3	29	Polygalaceae	3	14
Flacourtiaceae	7	8	Proteaceae	1	3
Gentianaceae	1	1	Rafflesiaceae	1	1
Gesneriaceae	10	41	Ranunculaceae	1	1
Gonystylaceae	1	8	Rhamnaceae	3	5
Goodeniaceae	1	1	Rhizophoraceae	3	7
Guttiferae	5	48	Rosaceae	6	12
Icacinaceae	4	6	Rubiaceae	43	116
Juglandaceae	1	1	Rutaceae	8	9
Labiatae	1	2	Sabiaceae	1	2
Lauraceae	12	63	Santalaceae	2	3
Lecythidaceae	1	2	Sapindaceae	13	21
Leeaceae	1	1	Sapotaceae	8	25
Leguminosae	16	29	Saurauiaceae	1	5
Lentibulariaceae	1	1	Simaroubaceae	3	3
Linaceae	2	2	Solanaceae	1	1
Loganiaceae	2	7	Sonneratiaceae	1	1
Loranthaceae	10	15	Staphyleaceae	2	3
Magnoliaceae	4	6	Sterculiaceae	6	9
Melastomataceae	20	54	Symplocaceae	1	4
Meliaceae	7	35	Tetrameristaceae	1	1
Monimiaceae	1	1	Theaceae	6	17
Moraceae	2	42	Thymelaeaceae	3	6
Myricaceae	1	2	Tiliaceae	3	10
Myristicaceae	4	27	Trigoniaceae	1	1
Myrsinaceae	3	17	Ulmaceae	1	2
Myrtaceae	7	67	Urticaceae	7	15
Nepenthaceae	1	10	Verbenaceae	8	14
Nymphaceae	1	1	Violaceae	1	2
Ochnaceae	3	4	Vitidaceae	4	4
Olacaceae	4	6	Winteraceae	2	3
Oleaceae	4	11			
Piperaceae	2	9			

Total Flowering plants 500 : 1541

species, but elsewhere in Sarawak (and probably in Borneo as a whole) similar vegetation has been largely cleared for cultivation of the land.

2.7.2.10 In Appendix III the species of Gymnosperm and Angiosperm plants recorded in the Park are given. This must be considered as no more than a preliminary enumeration, and consequent of the inclusion of the full results of the recent expedition and additional intensive research, the numbers are likely to be greatly increased. Nevertheless the totals seen on Table 10 of 500 genera and 1541 species are significant and provide an indication of the great value of the Park as a permanent and viable reservoir of genetical resources, and as an area of intense botanical interest. Within the limited area of the Park much of the diversity and complexity of the Bornean primary vegetation can be conserved in perpetuity, studied by scientists and students, and enjoyed by visitors.

2.7.3 Cryptogams •

2.7.3.1 Comparative data for Malesia and Borneo is scarce for all cryptogam groups except Pteridophyta where c. 400 species have been identified. Where information of any merit is available it is for the high altitude areas of the Kinabalu massif, and it is clear already that many of the endemic species of fern and bryophyte hitherto recorded only from Kinabalu can now be recorded from the montane forests of G. Mulu. Furthermore both terrestrial and epiphytic lowland species of ferns, again only recorded before in north Borneo are found to be sometimes frequent within lowland alluvial and dipterocarp forest of the Park. Although experts in a number of lower plant groups visited the Park during the RGS/Sarawak Government expedition the area of the Park they covered in their fieldwork is small.

2.7.3.2 The fern flora of the lowland wet limestone rocks is rich, especially in Aspleniaceae, Athyriaceae, although species are few in number. On the open rocks more xerophilous species may, in the absence of competition, become abundant eg. the local Phanerosorus sarmentosus. The geographical significance of the high altitude limestone, lying as it does between N. Thailand and New Guinea, is shown in the presence of the Himalayan Cheilanthes farinosa and the Mainland Adiantum malesicum. Such an isolated habitat also has its share of fern endemics (e.g. Adiantum hosei, Pneumatopteris eburnea). 19% of the Park's fern flora is confined to the limestone habitat.

2.7.3.3 Mosses are not abundant on the limestone or in the limestone forest but the number of species so far recorded is large. New species

• Data contributed by A.C. Jermy, W. Jülich and A. Touw.

to Borneo have emerged (e.g. Stereodontopsis flagellifera) and more are likely to do so when material is worked. Similarly a number of lichens will be unique to the limestone rock face.

2.7.3.4 The topography of the shales and sandstone massif of G. Mulu itself provides, in the form of streams and gullies, habitats where ferns abound. The most significant areas are the steeper slopes in the headwaters of the main rivers such as Tapin, Melinau Paku where clouds bank up and precipitation is high. Here genera such as Tectaria, Diplazium, Lindsaea and Asplenium are rich in species. Mosses are also rich in these rocky streambeds, one common species, in such habitats between 150-1200 m was the large and handsome Hypnodendron vitiense, new to Borneo.

2.7.3.5 In the upper montane forest (tall facies) mosses abound and many Bornean endemics grow here in profusion, e.g. Hypnodendron beccarii, Rhizogonium pseudo-distichum (only previously known from Kinabalu). Epiphyllous species that are widespread in SE Asia rain forest are to be found in abundance, often richly fruiting. In the short facies of the upper montane forest Bryopsida give way to Hepaticae. Ferns in these higher forests are frequently epiphytic, e.g. many Hymenophyllaceae and Grammitidaceae; the terrestrial species are often unique. e.g. Coryphopteris andersonii. On the more open ridges spectacular species of fern abound : Dipteris novoguineensis, Matonia pectinata and the giant forms of bracken, Pteridium esculentum; and in the rain gullies the bogmoss, Sphagnum perichaetiale, a species rare in Borneo. 45% of the fern flora of the Park is restricted to this habitat.

2.7.3.6 Lowland alluvial forests are again rich in moss species many of them sensitive to air moisture changes that even the felling of a single tree can drastically affect the flora. Among the epiphytes and plants hanging on dense undergrowth branches are species of Chaetomitrium and Taxithelium, genera with several Borneo endemics. Ferns here include several Lomariopsid species which begin life as a forest floor creeper and on climbing a sapling develop acrophylls (leaves of different morphology) and eventually fruit in the understorey canopy. Only 5% of the Park fern flora is restricted to the alluvial forest.

2.7.3.7 The cryptogamic flora of the kerangas on the Quaternary terraces is distinctive and contrasts with the more xerophytic type of kerangas seen elsewhere in Borneo. Further studies are needed to quantify the importance of the mixed type of kerangas seen on the low level terraces of the Setap Shale Formation.

2.7.3.8 A preliminary list of pteridophytes identified in the Park is given in Appendix IV and totals 442 taxa the better represented genera being Asplenium (18), Diplazium (25), Lindsaea (18) and Tectaria (16). One family studied in detail by R.E.Holttum, Thelypteridaceae, has shown, out of 50 taxa, 15 are to be described as new.

2.7.3.9 Fungi were collected over a period of three months by a specialist mycologist and over 4,500 species were found including many new species, genera and to date one new family. The richness of the lowland alluvial forest for this group of plants emphasises again the potential of this formation for future research. Lichenised fungi (Lichenes) are not common in the ever-humid forests but increase in diversity in the open scrub communities on the ridges. Folicolous species are abundant in the lower altitudes. Forest fungi cannot survive when the forest is removed. There are estimated to be about 8000 easily seen fungi within the Park.

2.8 The significance of the vertebrate fauna *

2.8.1 Thanks to the comparatively large contingent of participating specialists (most of whom had previous experience of the region) and to the generally settled taxonomy of most groups concerned, the R.G.S./ Sarawak Government expedition provided good coverage of the vertebrate fauna of the Gunung Mulu National Park. New records will undoubtedly be made (and the opportunity to do so should add to visitor-interest), but in the main, present lists (Appendix V-IX) must be reasonably complete in all cases except the snakes. It is immediately clear that the Park contains a rich assemblage of vertebrate species fully representative of this part of north western Borneo. So far, this fauna has been little affected in general by human interference, although there are signs of current over-hunting of certain larger mammals. Overall densities, however, are not high, and certain habitats support a particularly impoverished selection of species in low numbers. For several species the total population within Park bounds can only be considered at the best marginally adequate as a reserve to ensure future survival.

2.8.2 Mammals

2.8.2.1 Of the large mammals of particular interest in Sarawak, no signs were found of the presence of the following :- orang-utan (Pongo pygmaeus), known from archaeological work at Niah to have been present in the vicinity into the protohistoric period but only very rarely recorded in the Baram district in historic times; Sumatran rhinoceros (Dicerorhinus sumatrensis), reputedly exterminated in this area in the

* Account contributed by the Earl of Cranbrook

early 1940s and banteng (Bos javanicus), encountered in the upper Limbang in the early 1860s by Spencer St. John, but since then locally exterminated.

2.8.2.2 Of other important mammals that are commonly hunted in Sarawak, the Bornean gibbon (Hylobates muelleri) evidently has a restricted range in the Park. Although present from elevations of 100 - 1675 m on the slopes of G. Mulu including those of the Hulu Air Jernih and on the western edge of the kerangas-peat swamp forest terraces of the upper Mentawai drainage, this mammal was not noted either in alluvial forest habitat or on the limestone hills. Monkeys were more widespread, and included the high limestone peaks in their ranges. Yet certain species were absent from apparently suitable lowland habitat - notably in the lower reaches of the Melinau and Melinau Paku rivers, where hunting pressure is likely to have been most intense in recent years. The sizes of troops of leaf-monkeys (Presbytis spp.) in particular, also tended to be small by comparison with normal numbers in troops of related species elsewhere in undisturbed habitat in Malaysia. These observations indicate that the gibbon population and some monkey populations are already probably depleted by undue pressure from over-hunting. Nonetheless, all five monkey species expected on zoogeographical grounds are present, and their numbers are sufficient to allow an increase to natural densities if appropriate protection is given. The stock of bearded pigs (Sus barbatus), the only wild pig throughout Borneo, is moderate to low. Again, numbers could undoubtedly be adjusted within a decade or so by effective protection. At the same time, the role of pigs in park ecology (for instance, their effect on natural regeneration of certain trees or on the stability of alluvial soils) should not be overlooked. Continuous monitoring of the population and active management are likely to be needed.

2.8.2.3 Other ungulates are present at their normal, rather low densities: mouse-deer (Tragulus cf. javanicus) were encountered in the alluvial terr... and tracks, other signs or sound of barking deer (Muntiacus muntjak) and sambhur (Cervus unicolor) were noted from the flat lowlands to high elevations on Mulu itself; sambhur reached the true summit. Although sambhur tracks could still be identified in the mouth of Deer Cave, there was no indication that these were recent in origin; they could have been made several years ago. Tracks of the Malayan sun bear (Helarctos malayanus), Borneo's only bear, were also seen ranging up to high elevations on Mulu. Yet the total number of bears present in the Park, at the density indicated, is unlikely to exceed 100. Clearly, careful management is needed to safeguard the future of so small a population of a species subject to rather intense hunting pressure throughout its range in Sarawak.

2.8.2.4 Some of the cave-dwelling bats, by contrast, number thousands within the Park. Most notable is the huge colony of wrinkle-lipped bats (Tadarida plicata) in Gua Payau whose emerging flocks form a fascinating spectacle - whether seen at the cave mouth or from Long Pala. Nonetheless, it must not be forgotten that some cave colonies of related bats (Tadarida species) in North America, numbering thousands or even millions when first discovered, have dwindled drastically (in some cases disappeared altogether) in past decades. The reasons for such dramatic populations changes are not altogether clear; disturbance (i.e. by visitors, often unintentionally) cannot be discounted as a contributary factor, and safeguards need to be considered in G.M.N.P.

2.8.2.5 Other bats present in the Park include a large complement of small fruit bats, among them the grey fruit bat (Aethalops alecto), a montane species found elsewhere in Sarawak only in the Kelabit uplands and otherwise known in Borneo only from Kinabalu and the Crocker Range, Sabah.

Insectivorous bats recorded include both cave-dwelling and non-cavernicolous forms. Meaningful population estimates cannot be made, and further research will undoubtedly add to the list. Two species, the tailless horseshoe bat (Coelops robinsoni) and the round-eared tube-nosed bat (Murina cyclotis) are known in Borneo only from the neighbourhood of the Park; the records are based on specimens taken during the expedition.

2.8.2.6 Another discovery (or re-discovery) was represented by four Savi's pigmy shrews (Suncus etruscus) taken in pitfall traps. This mammal, one of the tiniest in the world (mass about 2 g) was previously known in Borneo only by a single specimen obtained at Bakong in the 1890s by Charles Hose. Because of its minute size, it evades the normal types of mammal trap. It may prove to be a widespread and not uncommon mammal of the forest floor.

2.8.2.7 Also present, but because of their nocturnal habits rarely encountered, are western tarsiers (Tarsius bancanus) and slow lorises (Nycticebus coucang), two small primates occurring only in Southeast Asia. Their overall distribution and density in the Park cannot be determined. The flying lemur or colugo (Cynocephalus variegatus) is present. Also largely nocturnal, it is again rarely seen. If met, it creates a memorable impression, with its strange appearance: a furred flight-membrane stretches from throat to tail tip, including all limbs to the extremities. Encumbered by the soft folds of this membrane, the animal normally hangs upside-down from small branches. It is largely incapacitated on the ground, but climbs tree-trunks quickly, if clumsily, progressing by strange lurching movements. Its numbers and distribution in the Park are, once more, unknown but no evidence was obtained that it was anything other than uncommon.

2.8.2.8 Rodents are well represented in the Park. Their distributions in the main are altitudinally restricted, with several montane specialists of great interest being confined to higher mountain slopes. In the lowlands, seven species of diurnal squirrel were noted, including two interesting Bornean endemics: the tufted ground squirrel (<u>Rheithrosciurus macrotis</u>), a very large, ground-dwelling squirrel, characterised by long ear-tufts and a huge bushy tail which is normally carried over its back, and the plain pigmy squirrel (<u>Exilisciurus exilis</u>), a tiny mouse-like squirrel normally seen in parties of 2-5, busily engaged in searching tree trunks or larger branches for some encrusting matter (?epiphytic lichens or algae) that attracts their close attention. Also present are the giant squirrel (<u>Ratufa affinis</u>) and the grey and white Prevost's squirrel (<u>Callosciurus prevostii</u>), tree-dwelling squirrels of the canopy, which attract notice by their loud, harsh calls and are thus liable to give a spurious impression of abundance. The four squirrels of the montane forests are all Bornean endemics. They are not difficult to find on the upper slopes of G. Mulu but their range is limited to elevations above about 1000 m, and thus confined to a small area of the Park. The rats also are not without interest. At each camp, the local forest-dwelling species quickly discovered foods poorly stored or carelessly discarded. In the alluvial forest, this was Mueller's giant rat (<u>Rattus muelleri</u>), on the mountain side the red spiny rat (<u>Rattus surifer</u>) and long-tailed giant rat (<u>Rattus sabanus</u>) and in the upper montane forest the mountain giant rat (<u>Rattus infraluteus</u>); the last is known elsewhere in Borneo only on Kinabalu and Trus Madi, Sabah. The long-tailed mountain rat (<u>Rattus rapit</u>) was taken at 1200 m on G. Api, a new record for the Park. Work during the expedition indicated that in the mature seral forest of the Melinau valley bottom, rats (all species) existed at an average density of 2.8 animals per hectare. Of the smaller murine rodents, only one tree-mouse was seen, at 1750 m on G. Mulu, and remains unidentified. This group in Borneo contains several interesting endemic species.

<u>2.8.2.9</u> Smaller carnivores (i.e., other than bear, above) are present in

expected diversity. No species is abundant, but any visitor out and about by night has a reasonable chance of an encounter. The area covered by a radio-marked Malay civet (Viverra tangalunga) during two months of tracking was 100 ha. The movements of this animal were, however, clearly influenced by the presence of the expedition base camp, and the range was probably not representative of natural circumstances.

2.8.3 Birds

2.8.3.1 Like the mammals, the birds of the Park are diverse, and fully representative of the expected fauna of inland, mountainous country in this part of Sarawak. The Park list, at the close of the expedition, stood at 262 species. These included ten non-breeding migrants from northerly subtropical or temperate latitudes in continental East Asia. Of 29 resident bird species endemic to Borneo, all but three have now been recorded within the Park bounds. Ringing has shown that members of one non-migratory species, the little spiderhunter (Arachnothera longirostra), are very mobile and may move several kilometres horizontally and several hundreds of metres vertically on the mountain slopes. Most small birds, however, proved to be largely sedentary in comparatively small areas, and only certain species, e.g. the swiftlets (Aerodramus species), daily make long journeys in search of food, probably ranging well outside the Park.

The distribution of birds is by no means uniform over the whole Park. Most species are confined to one or two restricted habitats. Important examples among these are the riparian habitat, i.e. the vegetation of the banks of larger rivers, the lowland alluvial forests and the montane forests. The richest bird fauna, assessed either by the number of species (about 200) or by the density of individuals, occurs in the low-lying alluvial forest of the riverine valleys. Yet even in this habitat birds are not especially numerous. Repeated netting at a surveyed plot in late seral secondary forest in the valley of the Melinau Paku indicated an average density per hectare of 16.5 understorey birds representing perhaps half the total bird population of this habitat. The seasonal fluctuation in this figure during the course of the year was apparently slight, as a consequence of a protracted breeding season, small clutch size and poor success in rearing young.

2.8.3.2 The slightly elevated kerangas/peat swamp forest evidently supports an impoverished selection of the avifauna of the alluvial forest, reduced by more than one half with the addition of merely one species perhaps locally unique to it : the ashy tailorbird (*Orthotomus ruficeps*). On the slopes of Mulu (southwestern approaches), a comparatively sharp faunal transition also occurs at the steep-land boundary (locally c. 130m above sea level), with the loss of many species characteristic of the alluvial forest habitat. In a few cases, these are replaced by close relatives, implying mutual exclusion mediated through ecological factors. Overall, however, there is a sharp reduction in the number of species present. Ascending the mountain, progressively more and more bird species evidently reach their upper altitudinal limits. At the boundary of mossy forest (which varies locally in elevation), there is another discontinuity at which specialised high montane species appear. At the highest level, about 27 species occur in mossy forest of the upper montane levels.

2.8.3.3 Despite the relative poverty of this avifauna, there are in fact only two bird species of upper montane habitat in Borneo absent from Mulu; both are, as far as known, confined to Kinabalu and Trus Madi, Sabah. The Park thus contains a nearly complete representation of high montane specialists available in this region. Some of these may find no more than the small areas of the summits suitable for their existence. Although locally common, often rather tame and easy to observe, these birds are surely very rare on a global (or even pan-Bornean) scale. Their conservation is a matter of importance, and their rarity will be a feature to attract the Park visitor.

2.8.3.4 Reviewing the Park's birds group by group, we note, first that water birds - not unexpectedly, in the absence of any lakes, swamps or tidal foreshore - are scarce. However, two of those observed in the Park (but not known to breed there), the oriental darter (*Anhinga melanogaster*) and Storm's stork (*Ciconia stormi*), have suffered reduction through human interference elsewhere in their range, and are now rare or local in some parts of S.E. Asia.

2.8.3.5 The eagles, hawks and falcons are well represented, with 13 species, including the rare Kinabalu serpent eagle (*Spilornis kinabaluensis*) elsewhere reported only from G. Murud and Kinabalu. and the specialised crepuscular bat hawk (*Macheiramphus alcinus*) which regularly harries the evening bat flight emerging from Deer Cave. Peregrines (*Falco peregrinus*) are resident, and appear to nest on the cliffs around Deer Cave (Gua Payau).

2.8.3.6 Eight of Borneo's 12 forest-dwelling galliforms occur in the Park, six at low to moderate elevations (but one only in the kerangas forest), two in the montane environment. Three Bornean endemics are present: Bulwer's pheasant (*Lophura bulweri*), crimson-breasted wood partridge (*Haematortyx sanguiniceps*) and red-breasted tree partridge (*Arborophila hyperythera*). Two species more widespread in the Sunda region locally reach the northern limits of their distribution in this neighbourhood.

2.8.3.7 Cuckoos are also well represented. All Borneo's five resident *Cuculus* species are present; other members of the family include the little known short-toed coucal (*Centropus rectunguis*) and the rare ground cuckoo (*Carpococcyx radiceus*), which is found only in Sumatra and Borneo. Observations within the Park of young of several of the parasitic cuckoos being fostered by smaller birds have added to the knowledge of the biology of this interesting group.

2.8.3.8 Three of the five swiftlets occuring in Borneo have been noted; the edible-nest species (*Aerodramus fuciphagus*) has been seen, but no nesting colony found. All six of Borneo's trogons are present, and not difficult to find. The largest, the endemic Whitehead's trogon (*Harpactes whiteheadi*), frequents the lower montane forest. It has been described as "one of Borneo's best birds". Of the six kingfishers, three are riverine - enhancing the pleasure of any boat trip - and three are forest-dwellers.

2.8.3.9 Most spectacular of forest birds, all Borneo's eight hornbills have been seen within the Park. In August-September 1977, large aggregations of hornbills were seen in fruiting fig trees, with up to 50 birds of up to four species present simultaneously. At other times of year, however, observers have failed to find such numbers. It may be that, after the end of the breeding season, virtually the entire local populations of rhinoceros hornbills (*Buceros rhinocerus*) and wreathed hornbills (*Rhyticeros undulatus*), in particular, assemble temporarily to form large flocks which wander over the whole Park in search of fruiting trees. The smaller species are permanently associated in family parties; these occupy ranges several kilometres in diameter. Despite regular sightings of hornbills by visitors, and occasional encounters of spectacular aggregations, it is probably unwise to assume that the Park supports unusually high numbers of these attractive birds. Moreover, the extent to which the large hornbills range beyond the

Park bounds, if only at certain times of year, remains unknown.

2.8.3.10 Also fruit-eaters, sharing this resource with hornbills and other birds, are the barbets; all the nine Bornean species have been noted. Each occupies a specialised ecological niche, in some cases excluding a counterpart species. Since each species of barbet utters a distinctive loud call, they contribute significantly to the day-time sound-scape of the Park. The visitor who learns these calls will quickly discover the ecological boundaries. The kerangas forest supports only a limited selection of two lowland species. Elsewhere, the determining factor is linked to altitude; on the mountainsides, the progressive impoverishment of the barbet fauna, and successive replacements of one species by another, are conspicuous audible features.

2.8.3.11 Among the many passerines, the broadbills include the beautiful black and crimson broadbill (*Cymbirhynchus macrorhynchos*) which builds bulky nests overhanging the larger rivers. The distinctive, rising calls of this and the forest-dwelling species are often heard; these can be learnt, with familiarity, and again provide an audible demonstration of ecological replacement. The Pacific swallow (*Hirundo tahitica*) nests on cliffsides and in cave mouths; from August to April, it is greatly outnumbered by migratory barn swallows (*H. rustica*), which become particularly conspicuous along the broader river courses but also range up to the mountain tops, feeding on air-borne insects. The bulbuls (21 species) are preponderantly lowland in distribution, with only the wide-ranging black and white (*Pycnonotus melanoleucos*), and the montane specialists *P. flavescens*, *Criniger ochraceus* and *Hypsipetes flavala* extending above 1600 m elevation. Of the remaining passerines, the babblers and flycatchers, sunbirds, flowerpeckers, starlings, white eyes, drongos and crows form diverse assemblages, separated by habitat and behaviour, and offering rich rewards for the careful bird-watcher. Finally, last on the list (see App. VI), the bamboo munia (Erythrura hyperythra) is known in Borneo only from the montane bamboo zone high on Mulu and on Kinabalu; few people have seen this rare bird alive.

Although the passerines may not contribute any spectacular element to the vertebrate fauna, the existence of this rich community of small birds, accessible and identifiable with comparatively little physical effort, will be a major attractant to the informed naturalist-tourist. Many visitors will rate the success of their trip in terms of numbers of species seen and identified, and it is this group of birds that will provide the chief opportunities for new and interesting observations. Many of the simplest details of their biology, such as nesting habits, feeding behaviour or song, are as yet poorly known. Even the transient visitor to the Park with luck is able to make new and useful contributions to knowledge.

2.8.4 Reptiles

2.8.4.1 Twenty-five species of snakes have so far been identified within Park bounds, i.e., about 15% of the total known from Borneo. Future work is certain to lengthen t is list.

2.8.4.2 Existing records include the regal python (Python reticulatus), the largest Bornean snake. A 17 ft specimen was found drowned at Long Pala; at the maximum, lengths of 30 feet and weights of about 250 lbs are attained. At the other extreme there are many small snakes, several of which are poorly known. In general, snakes are shy animals and escape as rapidly as they can if disturbed.

2.4.8.3 Of particular interest are the reed snakes , two of which (Calamaria borneensis and C. melanota) have been recorded in the Park. These are small burrowing snakes, usually discovered only by searching soil or litter, under stones or fallen branches. With limited powers of dispersal, localised endemic species of Calamaria often evolve; eleven have been described from Borneo.

2.8.4.4 Among other Colubridae, the speleologists recorded the cave racer (Elaphe taeniura) in several caves. Although often encountered in caves where it preys on cavernicolous vertebrates (bats and swiftlets), this snake shows no extreme specialisation for the habitat, and occurs also in forest where it is largely nocturnal. More likely to be noticed by non-speleological visitors are diurnal, arboreal snakes. This ecological group includes the colourful bronze-back (Ahaetulla prasinus) and keel-bellied whip snake (Dryophiops rubescens).

2.8.4.5 The Elapidae, one of the two families of true (front-fanged) poisonous snakes in the Park, are represented by three types. First, the red-headed krait (Bugarus flaviceps), which possesses a brilliant scarlet head and tail; if disturbed, the snake twists and coils with rapid, jerky motions, presenting a startling sight. Second, the banded coral snake (Maticora intestinalis) also distinguished by bright colour; above it bears a median longitudinal red or orange vertebral stripe, flanked by black and, low on the sides, by white stripes, and underneath it is barred black and white on the belly, black and red under the tail. This snake, if disturbed, also twists and writhes, raising the tail or rolling over to display its gaudily coloured underparts. In both cases, the behaviour serves to frighten any potential attacker and to give warning of the poisonous capacities of the snake itself. Third, the cobras (Naja naja and N. hannah), among which the warning behaviour consists of rearing up and spreading the so-called 'hood'. The second such family, the Viperidae, is represented by three pit vipers (Trimeresurus). Pit vipers often rest by day fully exposed on the ground or among the branches or low trees or shrubs. They are sluggish snakes, and generally will remain still unless actively molested.

2.8.4.6 Twenty-three species of lizards have been recorded in the Park (23% of the Bornean total). The seven geckos include three Cyrtodactylus species, two of which are of particular interest. One is an apparent cavernicole, related to *C. pubisculus*, and the other was taken high (1400 m) on G. Api. Both appear to be undescribed, and both may prove to be localised endemics confined to the Melinau limestone. Being nocturnal, they will be found only by careful searching of potential hiding places by day, or with the use of torchlight by night.

2.8.4.7 The ordinary visitor is more likely to encounter the diurnal lizards, the skinks and the agamids. The skinks are mainly ground-dwelling. The best opportunities to see them occur on clear, dry afternoons, when they can be found basking in sun-flecks on the forest floor. The agamids are mainly arboreal, and include four flying lizards (Draco spp.) three Goniocephalus species and three Phoxophrys species. Ecological interactions within each group are of much interest. The Draco spp. are evidentally partially separated by altitudinal preferences; dietic differences may also be important. The skinks also include two species pairs, between which similar separating mechanisms presumably operate. The study of such mechanisms is of considerable value in fundamental ecological research, and the Park is important as a site where investigations can be pursued in natural habitat.

2.8.5 Amphibians

2.8.5.1 Herpetological work during the expedition concentrated most intensively on the amphibians. As a result some 75 different species of frogs and toads have been recognised in collections from the Park. Fourteen of these had not been previously recorded from Borneo, and several are probably new to science. Six species taken at high altitude on G. Mulu are known elsewhere only on Kinabalu. The total amounts to two-thirds of the known amphibian fauna of Borneo.

2.8.5.2 Most diverse are the true frogs of the genus Rana (at least 14 species) and the tree frogs, Rhacophorus (10 species). But at least 12 other genera appear to be represented in the Park by more than one species. Thus the amphibians also provide valuable opportunities for research into ecological isolating mechanisms.

2.8.5.3 Most widespread in the Park is the frog Rana kuhli, found in swamp areas in the kerangas, and elsewhere in both slow and fast streams, by silty pools on the forest floor, and even on ridge tops at 1750 m. In general other amphibians have more restricted ranges in the Park. The ruling ecological factor appears to be the availability of suitable larval habitat. The tadpoles of some species at one extreme exploit more or less stagnant, shallow ephemeral pools or puddles on the forest floor, others are adapted to the deep, but rather sluggish water of the reaches of streams and the larger rivers, while yet others depend on the highly oxygenated water of the torrent streams of the mountain slopes. The Amolops and Staurois larvae are provided with ventral suckers by which they attach to rocks in fast-flowing water. Members of several genera exploit water contained in tree-hollows, and one (a Philautis sp.) has apparently evolved as a specialised breeder in the fluid held in pitcher-plants.

2.8.5.4 The communities of alluvial forest and low altitude mixed dipterocarp forest are approximately equal in size. Most of the former breed in shallow forest floor pools, six in slow, shallow streams or stream pools and four apparently require deep, slow water, i.e. rivers or backwaters. Of the mixed dipterocarp forest communities eight breed in shallow, fast streams, four require specialised breeding sites and four have unknown reproductive habits.

2.8.5.5 Four families are represented in the Park. Species of general interest can be mentioned briefly. Among the Pelobatidae, the 'horned' frogs (*Megophrys* sp.) rely for concealment on cryptic colouration and strange, un-frog-like contours; because they rest in exposed positions, they are in fact not difficult to find. Of the true toads (Bufonidae), the large *Bufo asper* is conspicuous on the river banks in the recent alluvial terraces, and its loud call attracts attention at night. The related *B. biporcatus* is found on the forest floor. Two *Pelophryne* species are separated by habitat; one frequents the dipterocarp forest, the other is on limestone where ever it outcrops and presumably specialised to this particular environment.

2.8.5.6 The Microhylidae include a *Calluella* sp., collected (once) only in the kerangas, and perhaps unique to this habitat. Three others (*Kalophrynus pleurostigmata*, *Metaphrynella sundana* and *M. borneensis*) include kerangas forest in their ranges.

2.8.5.7 The Ranidae include members of the *Rana macrodon* group, among the largest frogs in the world. All or most of these are taken for food in Sarawak, and as a consequence are vulnerable to hunting pressure. In many parts of their range, the local representative species are severely over-exploited, and populations are much depleted. The Park populations, are particularly vulnerable to catastrophic disturbance, to a far greater extent than any other vertebrate group. The Park contains the watershed between the Melinau-Baram catchment and that of the Medalam-Limbang. Ecological comparisons of the fish in waters of these two drainage systems will be instructive. It is important scientifically that the fish are not visualised in a Park management scheme solely as a source of food (for staff or for visitors) or for recreation through angling, but that they are conserved, by effective measures, along with other vertebrate inhabitants. In the long term, it is very likely that the rivers of the Park will prove important as breeding refuges from which young fish will spread downstream to repopulate the waters of the Tutuh, Baram, etc., where freshwater fish are heavily exploited and provide an important contribution to human diet.

2.8.7 Conclusion

2.8.7.1 This survey of the vertebrates emphasises that the richest communities of all five classes are to be found in the recent alluvial terraces. Excluding the kerangas and peat swamp forests, which are inhabited by a depleted fauna (with the addition of a very few specialised forms peculiar to these habitats), the lowlands of the Park undoubtedly support the great majority of vertebrate animals contained within its bounds. It proved possible to delineate the margin of this rich zone most closely in the case of birds. It correlated with a distinct topographical feature - the steep land boundary (at about 130 m above sea level, on the southwestern approach to G. Mulu). It is probable that this boundary also operates with other classes, except perhaps fish for which the transition from a fast, normally silt-free, torrent to a meandering stream is probably more decisive.

2.8.7.2 Not only is the lowland forest richer in species, for birds, at least, it appeared that reproductive success was higher than in other habitats. The lowlands may therefore act as a reserve from which populations of certain species are maintained in less productive adjoining habitat. Yet it is precisely the lowland area that is most vulnerable to deleterious outside influences, including the depredations of those local people who hold hunting privileges, and the pressure of Park visitors themselves.

2.8.7.3 Moreover, lowland alluvial habitat forms only a small proportion of the Park area. Much of the Park is elevated land, exceeding 130 m a.s.l.; if extension is possible, it is lowland habitat that requires additions.

2.8.7.4 Other habitats are still also of great biological importance. The cave system, although not old, harbours a trogophile snake and a troglobiont gecko that may be endemic, in addition to the large populations of cave-roosting bats and birds which emerge daily to seek their food outside. Above ground, the demanding environment of the limestone appears to support specialised frogs, if not other vertebrate types, peculiar to itself. Among all terrestrial vertebrate classes, ecological separation of the rich and diverse assemblage of species in the Park is achieved by varied processes including altitudinal zonation. Although, above the steep land boundary, no ecotones were discerned corresponding precisely to the floristic communities recognised by botanists, there are continually changing (in the main reducing) vertebrate assemblages on the mountain slopes, their ranges restricted by altitude or by factors related to altitude.

2.8.7.5 Among all terrestrial classes, the most impoverished (and also perhaps the most specialised) assemblage is that of the mossy forest on the higher peaks within the Park. The few species confined to this zone are presumably adapted to the exigencies of the environment. Yet the small area of suitable habitat available to them must of necessity limit the size of their populations. Such small populations must (like the population of a remote island of equivalent area) constantly be subject to the risk of catastrophic disaster and even extermination. The surveys of the high altitude vertebrates of G. Mulu, performed by RGS expedition members, stand as a landmark in the history of this area. Among the many interesting developments to be watched for in the future is the possibility of local extinction of a high altitude specialist animal. No management plan can totally prevent such an eventuality. But at least it must be hoped that effective monitoring will identify the event as soon as it occurs.

2.9 The significance of the Invertebrate fauna

Account contributed by N.M.Collins

2.9.1 Introduction

2.9.1.1 The total number of invertebrate species in the Park may be estimated in the order of 20,000, the largest groups being Coleoptera (c. 8000 spp.) and Lepidoptera (c. 3000 spp.). Many other insect groups are also represented as are annelids, myriapods, crustaceans and molluscs. Their identification is very time-consuming and the availability of information emerging from the collections made on the R.G.S./ Sarawak Government expedition is limited by relevant expertise and the paucity of earlier taxonomic work on many of the groups concerned.

2.9.1.2 The following comments on invertebrates are therefore only preliminary and when the material has been studied more closely a much clearer picture of invertebrate diversity and density in relation to forest type will emerge. Eventually it may be possible to use key groups to help categorise forest types and already certain diagnostic characters are known and referred to below. It must be emphasised that invertebrate studies at G. Mulu have only just begun and further projects will be of great advantage.

2.9.2.1 Platyhelminthes

Planarian flat worms (Turbellaria) were recorded in the Melinau and its tributaries. Land planarians were also found quite commonly in the alluvial forests, protected from desiccation by the humidity and a body covering of slime. They may be aposematically coloured (one common one, Bipalium sp., is striped black and yellow) and usually have an arrow-shaped anterior. They were also found in boggy peat at 1310m and 2070m on Mulu.

2.9.2.2 Temnocephalida (Turbellaria) live commensally on the outer surfaces of various freshwater animals. Many specimens of freshwater crabs caught in the alluvial forests were found to be harbouring Temnocephala semperi, a species not previously recorded in Borneo, in their branchial cavities. They were first noted in picric acid pitfall traps containing crabs but were also found in traps without crabs.

2.9.3 Annelida

2.9.3.1 Oligochaeta (earthworms and allies) were found to be an important and numerous element in some soils. The larger earthworms were all Megascolecidae, lowland specimens being perichaetine genera related to Pheretima, a large genus currently under review. Soil coring also revealed an interesting distribution of octochaetine genera. They were only found in peaty soils between 1300 and 1860 on Mulu, for which there is no obvious explanation. The perichaetine genera related to Pheretima lack calciferous glands and specialise in low pH habitats. Very low populations were found in limestone forest where the soil pH is relatively high. In kerangas, dipterocarp and alluvial forests populations in the region of $30m^{-2}$ were recorded. Numbers were considerably higher in lower montane peaty soils up to about 1860m but were reduced in upper montane soils. None were recorded above 2070m where there were indications that Enchytraeidae were the prevalent annelids.

2.9.3.2 An unusual arboricolous earthworm, Planapheretima sera, has been recently described from G. Mulu. Related species are known from China, Burma, Sulawesi and New Guinea. The species appears to feed on epiphytic decomposing material and is well adapted to life in the trees. It is dorso-ventrally flattened, cryptically coloured and has ventral concentrations of

setae and surface glands. Other aboricolous species are present in roots of epiphytes in alluvial and dipterocarp forests.

2.9.3.3 Moniligastridae were common in soil cores up to 1650m on Mulu but were not recorded above. Very little is known of the ecology of this mainly Southern Asian family of oligochaetes except that they prefer boggy habitats. Three of the five known genera, Desmogaster, Drawida and Eupolygaster are known from Borneo but as yet the Mulu material has not been identified.

2.9.3.4 Hirudinea (leeches) were widely collected, and although they are very much a character of Sarawak's forests, much remains to be learnt of their habits. The familiar blood-sucking leeches Haemadipsa zeylanica and H. picta (Gnathobdellidae) are common from the lowlands up to 1200m on G. Mulu (upper limit of lower montane forest). They are absent or rare on limestone and occasional in the kerangas. Studies on H. zeylanica (common ground leech) showed that they can survive for up to six months without feeding and each meal consists of an average 0.04g of blood. Above 1200m on Mulu careful searching in moss and soil revealed several species of Pharyngobdellida. These are predators of worms and insect larvae and can reach a length of 30cm. They are not found below upper montane forest and have been recorded from other high mountains in Borneo (Murud and Kinabalu).

2.9.4 Mollusca

2.9.4.1 Terrestrial molluscs are generally considered to be rare in tropical rain forests, probably as a result of low soil pH values. Evidence of mollusc distribution in the Park is scarce and relies only on casual collecting and general soil faunal studies.

2.9.4.2 No molluscs were recorded in kerangas or dipterocarp forests. Slugs

were very rare and only recorded in small numbers from alluvial forest and high altitude montane forests (1970 and 2030m). Snails were most common on the higher soil pH limestone regions, where Cyclotus sp. (Cyclophoridae) was abundant in the lowlands. The alluvial forest soils, where soil pH was also ameliorated, supported a diverse snail fauna, but of very low abundance. There is no information available for freshwater molluscs.

2.9.5 Arachnida

2.9.5.1 Scorpionida were common but not diverse, occurring as high as 2070m on Mulu. The large forest scorpion (Heterometrus longiamanus) was sometimes seen by day in leaf litter but the small forest scorpion (Homurus australasiae) was more secretive, living under bark and in logs.
2.9.5.2 Uropygi (whip scorpions) were collected in small numbers. Most were taken in alluvial forests where they live under bark and logs. Several were taken from floating debris during floods, an excellent time to collect litter fauna in general. Shizomida are small (up to 1 cm), blind arachnids with a short three-segmented tail. They were found in soil cores, mainly in dipterocarp forest, but also in alluvial and kerangas forests.

2.9.5.3. Amblypygi (tail-less whip scorpions) have long whip-like, tactile front legs well-suited to dark caves where several were taken.
Araneae (true spiders) were of course abundant throughout the Park but there was a slight reduction in family diversity towards the summit of Mulu. Dipterocarp and alluvial forest soils contained several more families than kerangas. Salticidae (jumping spiders) were thoroughly collected and many ant-mimics found, including 13 species of Myrmarachne and specimens of Cosmophasis, Bocus, Morengo and the attractive Orisma. Many were new, including a Myrmarachne from the summit of Mulu. In the same locality a new

species of Theridion (Therididae) was found to build a web inside the funnels of the pitcher plant Nepenthes muluensis. Miseumenops nepenthicola is known for similar habits in other pitchers. The larger tarantula-like specimens of Theraphosidae were surprisingly scarce, only one specimen being found (at Base camp). Highly venomous genera like Latrodectus (black widow) were absent and are so far unrecorded from Borneo despite a wide distribution in other parts of South-East Asia. The large web-spinning species of the genus Nephila (Araneidae) were quite common and one female was observed to spit under duress. The webs of Argiope spp. (Araneidae) have a very distinctive cross and were common in clearings. The attractively sculptured spiny-back spiders (Gasteracantha), with long, curved abdominal processes were found around Base Camp and elsewhere. Blind specimens of Gnaphosidae, Zodaridae and Clubionidae were found in soils and caves. At night huge numbers of Sparassidae (huntsmen) could be collected by torchlight and in the caves one was found to have extended tactile fore-legs. The cave fauna as a whole will be of particular interest but awaits further attention. Many species take on very pale colours when living in dark caves. Notable exceptions are some pitch-black Pacullidae found under rotten limestone boulders deep inside Lubang Rendah Harimau.

2.9.5.4 Pseudoscorpionida and Opiliones (Harvestmen) were commonly found in plant litter and soils up to about 2070m on G. Mulu but no information on their taxonomy is available as yet. These two groups were less common in alluvial soils liable to flooding and pseudoscorpions were not recorded in kerangas forest.

2.9.6 Crustacea

2.9.6.1 Freshwater crabs (Decapoda: Brachura) In the alluvial plains of the

Melinau and Melinau Paku the abundance of crabs (0.35-0.40 m^{-2}) renders them an important and diagnostic component of the otherwise often impoverished soil fauna. They are nocturnal scavengers feeding on some insects and rotting vegetable matter and probably play an important role in decomposition processes in alluvial forests. Four species were found: Perbrinckia loxophthalma, Thelphusula baramensis and Thelphusula granosa are all Gecarcinucoidea, endemic to Borneo, while the less common Geosesarma gracillima (Grapsoidea) is also known from the mainland and the Natuna Islands. They all live in deep (up to 1m) burrows in the wetter anaerobic soils of the alluvial areas, but one specimen of Thelphusula baramensis was caught in kerangas forest on terraces near the Melinau Gorge. Several other species were found associated with rivers and sink-holes. A new white troglobitic crab Cerberusa caeca with very reduced and functionless eyes, was found in Gua Payau, Lubang Hijau and Gua Air Jernih living in small pools and feeding on swiftlet carcases and other debris. Another new species, Isolapotamon collinsi, was found in a sinkhole in Hulu Air Jernih. Several species of shrimps of the genus Macrobrachium were taken in Gua Payau and Gua Air Jernih.

2.9.6.2 Substantial collections of Isopoda were made, including Cyathura sp., a new species of troglobitic Anthurid. The genus is of ancient marine origin and is potentially of great zoogeographical interest since it is otherwise known only from New Guinea, Mexico and the Caribbean. Other species of terrestrial isopods (wood-lice) were collected in soil cores but have not been identified.

2.9.6.3 Diplopoda were collected in all the main vegetation types and populations and species diversity were generally found to be low. Millepede populations are low on the sandstones of G. Mulu, with the lowest in the

dipterocarp forests. There is evidence for a slight increase in numbers in the gley soils of the lower montane and alluvial forests. It is interesting that the distribution of millepedes closely follows that of woodlice. The greatest density of millepedes was in the high pH soils of the limestone forest where soil coring suggested densities of about $60m^{-2}$. Many of these individuals attained a greater size than was observed in other forest types. Several species were found to be mainly fungus-feeders, a rather unusual habit for the group.

2.9.6.4 Chilopoda were found to be distributed more evenly, probably a reflection of their predatory feeding habits. Geophilomorpha are the most numerous group in the soil although Scolopendromorpha are common in the litter and surface soil layers. Their greatest density in litter was found to be in the kerangas forest, possibly feeding on the dense termite populations. The dangerous and fast-moving long-legged centipedes of the Scutigeromorpha were collected in a variety of forest types, as high as Camp 4 at 1800 m. Their greatest density however, is probably in the caves. The caves also harbour large populations (up to $6m^{-2}$ on guano heaps) of luminous geophilomorph centipedes.

2.9.7 Insecta

2.9.7.1 Apterygote insects (Thysanura, Diplura, Protura, Collembola)
Preliminary data suggest that Collembola are an important component of montane soil fauna, but are relatively few in the lowlands. Diplura were mainly predatory Japygoidea with only a few Campodeoidea represented.

2.9.7.2 Exopterygote insects (except Isoptera) were not sufficiently collected although substantial numbers accrued from general collecting.

Phasmida were noted as a numerous element in the montane vegetation of G. Api. Amongst the 200 specimens of Orthoptera collected Locusta migratoria manilensis was taken on the Base Camp helipad - a reminder of what may be in store if large areas are cleared. The species occasionally swarms and causes considerable damage in Sabah. Interesting semi-brachypterous Epilamprid Cockroaches (Dictyoptera), were common in montane peat soils. Of the earwigs (Dermaptera), Arixenia is of most interest, being blind and supposedly ectoparasitic on the hairless bat (Cheiromeles torquatus). Despite the fact that hairless bats were not an important component of the cave fauna, there were large populations of earwigs on the Gua Payau guano heaps. The small collection of earwigs from soils on Mulu suggests a possible altitudinal division with Brachylabis collinsi in the lowlands and Gonolabis spp. (both Carcinophoroidea) above 800 m. A large species of earwig was one of the few predators observed to feed on Hospitalitermes columns (see below).

2.9.7.3 Termites (Isoptera) are well-known to be of great importance in tropical soils and were the subject of a major research project. The greatest diversity of 59 spp. was in the dipterocarp forest while the alluvial forests had 31 spp. and the kerangas only 24. However, the highest populations of soil termites were in the kerangas (up to about 1400 m^{-2}) where they are considered to be of great importance in nutrient cycling. The majority of termites found in the Park are from the Rhinotermitidae (dampwood termites) and the Termitidae subfamilies Termitinae and Nasutitermitinae, both rotten wood and soil feeders. The fungus-growing Macrotermitinae are comparatively rare. Of particular interest are the surface-foraging columns of Hospitalitermes and Longipeditermes (Nasutitermitinae), most commonly seen in the dipterocarp and kerangas forests. Two new genera of Nasutitermitinae were discovered near Camp 1 and this was the only place where Hirtitermes

were scarce in kerangas. The prevalence of trees with sclerophyllous leaves and consequent low mammal populations are probably responsible.

2.9.7.7 Diptera Any camp built near a river in the alluvial plain is susceptible to the diurnal attacks of a tiny biting midge *Forcipomyia* sp. nov. (Diptera: Ceratopogonidae) which breeds in damp soil, moss, sandbanks and rotten stumps. It seems highly probable that the Ceratopogonidae are responsible for transmitting various viral diseases, but their small size has so far precluded confirmation of their role as vectors. Heavy future use of riverine camps in the Park may necessitate control or precautionary measures against them.

2.9.7.8 A collection of Diptera larvae from soil cores on an altitudinal transect of Mulu suggested a major change at the dipterocarp/lower montane forest ecotone. Diptera larvae were more common in the peaty montane soils, with a particular prevalence of Mycetophilidae/Sciaridae and Tipulidae which may occur in groups of 100 or more. Chironomidae larvae, which are aquatic, occurred in some numbers in lower montane soils, reflecting their boggy nature. Hydrophilidae (Coleoptera), which live in aquatic or very wet habitats, were also found here.

2.9.7.9 Lepidoptera were collected by light trap at 28 sampling sites in a very thorough search for diagnostic associations with forest types. Over 10,000 specimens (mainly moths) of about 3,000 species were taken. It is considered that over 80% of Borneo's recorded Lepidoptera are to be found within the Park's boundaries. A thorough analysis of the data is not yet possible but preliminary examinations suggest strong correlations between moths and vegetation types. The survey will eventually provide results which may be of great value in monitoring changes within or around the Park.

2.9.7.10 Of the Hymenoptera, the ants (Formicidae) were very thoroughly collected and 458 species of 78 genera were found. This is more species than occur in the whole of North America, and represents one of the largest collections ever made in such a small area. The termites and ants between them dominate the soil fauna in all lowland forest types and high up into the lower montane regions too. Two new genera of ants have been found and many others are rare or previously unrecorded from the region, including Stenamma, Eupalothrix, Dysedrognathus, Amblyopone, Euprenolepis and Anillomyrma. In the nutrient-poor kerangas soils Iridomyrmex is found in mutually beneficial associations with ant-plants such as Myrmecodia and Hydnophytum. Also in the kerangas, Nepenthes bicalcarata supports an opportunistic ant Camponotus sp., which lives in its curled petiole and carries out sorties into the pitcher itself. Studies on other hymenopterous groups are needed.

2.9.7.11 Thysanoptera from about 10 genera and 15 species were represented in pitfall trap samples indicating a diverse fauna at ground level. Most specimens belong to two or more species of the genus Thrips which feed on flowers or leaves. The majority of species however, are true litter fauna feeding on fungi. Of these, the most common genus, Psalidothrips is previously recorded from the Neotropical and Oriental regions but is a new find for Borneo. Thrips are of great importance in pollinating certain trees and canopy studies would no doubt reveal a much greater diversity than is so far known.

2.9.8 Conclusions

2.9.8.1 Knowledge of the Park's invertebrate fauna is fragmentary and largely superficial. The emphasis of studies so far has been on litter and soil fauna while the aerial and canopy forms (with the notable exception of the Lepidoptera) have scarcely been examined. Even so, the detailed studies of the soil fauna have served to illustrate the way in which the Park's variety of bedrock, altitude, climate, soils and vegetation is reflected in the invertebrates. In some cases diagnostic and important groups of soil organisms have been identified: crabs in the alluvial plains, termites and ants in the dipterocarp and kerangas, coleopterous and dipterous larvae in the upper montane. In the lower regions of the limestone mountains of G. Api and G. Benarat heavily armoured invertebrates like millepedes, woodlice and snails achieve their greatest densities. Such areas are of great value for comparison with the sandstone vegetation of G. Mulu. The importance of the caves in interpreting the history of the fauna of the area must be stressed. They represent a unique habitat with many interesting biological problems. The guano-based economy of the rich invertebrate fauna has so far only been touched upon.

2.9.8.2 The invertebrates have an important role to play in the Park ecosystems - in decomposition and nutrient cycling, pollination, and other insect/plant relationships, biological control and food webs. The inventory of invertebrates that is emerging from the researches of the R.G.S./Sarawak Government expedition (for example see App. X) is a taxonomic base-line from which further studies on the role of invertebrates in rain forests can be pursued. This has important implications for the scientific management not only of the Park but of other areas in Sarawak being developed for silviculture and agriculture.

3 PRESENT UTILIZATION OF THE PARK

3.1 Local People Inhabitants of the longhouses and nomadic Penan have defined hunting, fishing and gathering privileges in the Park. The individual groups of people are considered separately as they are in the Gunung Mulu National Park Proclamation (App. II, see also para 1.5.2)

3.1.1 Penan

3.1.1.1 An intensive study of the Penan community was undertaken by Peter Kedit (Sarawak Museum Field Report, No. 1 A human-ecological survey of the nomadic/settled Penan within the Gunung Mulu National Park; see Appendix XI) Additional information was also obtained by other members of the expedition, notably the medical nutrition specialist, Dr A.J.U. Anderson, by the vertebrate zoologists, Lord Medway (now Earl of Cranbrook) and Mr David Labang and by the palm specialist, Dr John Dransfield. Some results of this research, in so far as they indicate the extent to which the Penan population utilizes the Park are summarized below.

3.1.1.2 The Penan, comprising both the semi-settled and truly nomadic people, range widely through the Park and surrounding area, and undoubtedly make far greater use of the Park than do the other privilege holders from the longhouses in the Tutuh and Seridan rivers in the Fourth Division and in the Medalam river in the Fifth Division. The main concentrations of Penan are on the south-west perimeter of the Park in the Melinau river, at Long Iman, and in the Ubung river area. It was concluded that not more than twenty families totalling 140 individuals, from the Melinau river make full use of the Park.

The Penan from Long Iman and the Ubung river are only partial users as their main hunting and gathering grounds are outside the Park. In addition perhaps another sixty families may be considered as occasional users.

3.1.1.3 The forest paths (almost indiscernible to the uninitiated) followed by the Penan range over all areas of the Park, though the limestone and the higher slopes (above 200 m; 4000 ft) of Gunung Mulu are avoided. The location of these paths is shown on Map 6.

3.1.1.4 The staple diet of the Penan is the wild sago palm (Eugeissona utilis) which occurs on the crests of sharp, partially exposed, ridges below 900 m (3000 ft). It is less common on the Setap Shale Formation but is found on the margins of some of the higher terraces. Most of the Penan paths follow routes where the wild sago is known to occur and these localities are visited periodically. Other sago-producing palms, that are also sought after, and indeed may be preferred to Eugeissona, include Caryota no, C. utilis and Arenga undulatifolia. In addition, in many palm species the terminal shoot is edible and the plants may be cut for this purpose. Also some species, especially those in Daemonorops and Salacca provide edible fruits. Forty-nine other fruit-bearing species were recognised by Penan in Kedit's recent survey (see Appendix XII).

3.1.1.5 The Penan obtain their animal protein mainly from mammals. The principal mammal that is hunted is the bearded pig, though porcupines, mouse and sambhur deer are also sought after, and to a lesser extent other mammals that are encountered. Monkeys and gibbons are also much prized game, as well as the larger birds, including the hornbills. The blow pipe is still the main weapon used, and there is some evidence to show that the Penan can be remarkably selective when using this weapon. There is a limited amount of trapping for smaller game and birds. The leaf monkeys are occasionally hunted for bezoar stones, in which case a large number of animals may be unnecessarily killed. The annual harvest of meat taken by the Penan is not accurately known, but over short periods sample family intake varied from none to ten monkeys (of three species) in 10 days.

3.1.1.6 Traditionally the Penan are not river folk, and their fishing activities in the past, using mainly a hook and line, are likely to have had little impact on the fish populations of the Park. The settled community at Long Iman nowadays makes use of nets to harvest in the vicinity of their village.

3.1.1.7 Traditionally the forest has provided all material necessities of the Penan except metal objects, some cloth, sugar, salt and tobacco. Selected plant species provide material for such diverse uses as for house building and roofing and for blow pipes, darts, poisons, containers, musical instruments, dyes, soaps, and medicines (Appendices XIII-XV). Especial mention must be made of the numerous uses for rattans, which are therefore in danger of being over exploited and depleted, and similarly *Licuala lanata* a newly discovered endemic palm and the preferred species for thatching.

3.1.1.8 Collection of plant products for sale is on a limited scale. Notable items include damar, and gums from jelutong (*Dyera costulata*) and gutta percha (*Palaquium* spp.). In the past two years the highly inflated price for geharu, an incense wood obtained from *Aquilaria microcarpa* has led to widescale felling in the search for marketable portions of this timber. Some cash is also obtained from the sale of the traditional, extremely fine rattan products.

3.1.2 Other privilege holders

3.1.2.1 The extent of the use of the Park by other privilege holders is little known. Those from the Tutuh and its tributaries visit the park on hunting expeditions, and when accompanying visitors tend to occupy spare time by gathering forest produce, wild fruit, etc. In the past in the southern range of the Park the two species of Belian, *Eusideroxylon zwageri* and *E. melagangai*, were felled and the timber hand sawn to provide material for house building, but there is little evidence of felling of trees here in recent years. Rattans are collected by these people personally, and jungle produce, including artifacts, is also purchased from the Penan and then resold down river at a profit.

3.1.2.2 The hunting privileges of the inhabitants of the longhouses are confined to deer and pig, but since the constitution of the Park there has been no formal monitoring of this activity. Casual observations suggest that other mammals and the larger birds have also been killed. Shot guns are in universal use. It is clear also that the inhabitants of the Tutuh longhouses have not in the past confined their hunting activities to localities where they have the privilege. Hunting expeditions are mounted when the pig are known to be on the move and in some abundance in the Park; the Melinau area, particularly the alluvial plain, is a well known hunting ground at such times and attracts people who have no privileges in the Park.

3.1.2.3 During visits to the Park, either on hunting expeditions or accompanying visitors, these same peoples exert their privilege to fish the Melinau and Melinau Paku rivers and their tributaries making use of small mesh nylon pukal and jala nets. There have also been reports of the illegal use of tuba poison in the Melinau river both downstream and at the Gorge.

3.1.2.4 The inhabitants of the longhouses of the Medalam river have the same privileges to hunt pig and deer and take fish within the drainage of the Mentawai river and its tributaries. Unlike the inhabitants of the Tutuh they do not have the gazetted privileges of collecting produce. Until recently they probably were largely unaware of the limits of their privileges, or chose to ignore them. Hunting parties have been met far outside the drainage area of the Mentawai. Their gathering activities are largely similar to, though probably more extensive than, those of the Tutuh peoples. In addition some trees, mainly merantis, have been illegally felled.

3.1.2.5 The Ibans in particular are avid hunters and it is clear that they have roamed far outside the Mentawai drainage. Evidence of their activities was found on the alluvial plain in the drainage of the Tarikan and also upstream in the Medalam river. Hunting expeditions will kill all manner of game and any excess of meat will be dried to take back to the longhouses. Similarly fishing expeditions will often catch a surplus of fish. They are known to use tuba poison illegally and it was reported that they were responsible for the illegal tuba fishing in the Melinau Gorge previously mentioned.

3.1.2.6 The inhabitants of Long Seridan have the privilege to hunt pig and deer and take fish and jungle produce in the drainage of the S. Ubung and its tributaries. They probably make little use of the Park though their activities have not been monitored. These people may also to a limited extent partake in gathering and hunting activities along the Tutuh river, upstream of the rapids.

3.2 Visitors

3.2.1 The numbers of tourist visitors to the Park before 1977 were very limited. The National Parks Section does not have a record of all parties entering the Park as some proceeded independently without permission and made arrangements directly with the inhabitants of Long Terawan. It is estimated that about one party a month visited the Park. All parties proceeded via the Tutuh river and Long Pala and most made the ascent of Gunung Mulu, visiting also Gua Payau. There is no record of such visitors entering the Park from the north along the Medalam and Tarikan rivers.

4 PRESENT UTILIZATION AROUND THE PARK

4.1 Forests and forestry

4.1.1 The Park is at present surrounded by primary forest, with the exception of small areas for short distances along the cut boundary between the Langsat and Melinau Paku rivers, where some shifting cultivation occurs. The steep rugged terrain on the left bank of the Tutuh river to the base of the rapids falls within the Melana Protected Forest (a 'protected forest' is a legally constituted government reserve, under the authority of the Forest Department, in which no farming is permitted, unless such rights or privileges were admitted at the time of constitution, but in which native peoples may hunt, fish or gather produce for their own consumption or use but not for sale or barter). In the north-east the land on the true right bank of the Medalam river, from its source to a point downstream of Nanga Mentawai, lies within the Medalam Protected Forest. It is proposed (see Chap. 6) that this area should be constituted as an extension to the Park.

4.1.2 A forest logging licence has been issued by the Forest Department for the area of land on the SW of the Park that lies between the Melinau river and the Brunei border. By September 1978 no timber had been extracted under this licence though the licensee had undertaken some preliminary surveys. The Director of Forests has prohibited the felling of any trees with a distance of 40 chains (800m) of the Melinau river in order to provide a buffer zone for the Park (see para 8.2.5) It is understood that another forest logging licence has been issued covering, wholly or partially, the Melana Protected Forest. There also, no felling or extraction of timber had been undertaken by the end of 1978. No licences have yet been issued for the Medalam Protected Forest but the land beyond this reserve is included in a licence that covers much of the headwaters of the Limbang and Mendamit rivers.

4.2 Hunting, fishing and gathering produce

4.2.1 Both the Melana and Medalam Protected Forests are traditional hunting and gathering grounds of the Penan. The former area is probably rarely visited by the inhabitants of the longhouses in the Tutuh river, though those from Long Seridan may occasionally hunt there, as also along the true left bank of the Ubung river. The inhabitants of the longhouses in the Medalam river are known to hunt fish extensively in the headwaters of this river. It is probable also that there is some gathering of produce particularly rattans, by these people but the extent is not known and there is certainly limited felling of trees, particularly meranti, for boat manufacture. In recent years there has been an intensive collection of geharu or incense wood from trees of Aquilaria microcarpa from all localities.

4.3 Farming

4.3.1 Though, as mentioned in para 4.1.1, farming in the immediate vicinity of the Park is negligible, further downstream both in the Tutuh and Medalam rivers shifting cultivation is extensive. The population of the Tutuh longhouses has probably remained fairly stable during the past two decades and little additional forest has been cleared for cultivation. Land around the recent Penan settlement at Long Iman has been cleared for cultivation. But in the Medalam river there has been a significant increase in population mainly as a result of migration of Iban from the Second Division. Consequently extensive areas of forest almost to Nanga Mentawai have been felled and cleared in the last twenty-five years.

5. PROPOSED ROAD THROUGH THE PARK

5.1 The Pan-Sarawak Highway is scheduled to be extended to link up the Fourth and Fifth divisions from Beluru to Medamit. This will provide a road link with Limbang and by-pass the present route through Brunei. No final decision on the construction of the road has been taken, but the proposal has been included in the Fourth Malaysia Plan, 1981-85, and preliminary estimates submitted. It is understood that construction is unlikely to start until 1983 or 84, and it appears unlikely that any constructional work within the Park itself will be undertaken during the period of this plan.

5.2 Route Possible road alignments have been investigated by the Jabatan Kerja Raya (Public Works Department), mainly by means of aerial photographic interpretation, though some field work has also been undertaken. The two alternative alignments through the Park have been considered; Map 7 shows the southern alternative that is preferred by the J.K.R., and is likely to be chosen. This route enters the Park in the north-western corner, crossing the headwaters of the Lutut at approximately 93km from Beluru, at a distance of only approximately 1.5km from the Brunei border. It then proceeds in a north easterly direction and crosses the Mentawai river at km 99.3. The north-eastern alignment of the road through the Park is not known, but it appears probable that it will continue on the true left bank of the Mentawai river and debouch from the Park within one to two kilometres of Nanga Mentawai. The total distance through the Park will be approximately 11.5 km.

5.3 Access to the Park This road will totally after the accessibility of the Park. Road transport, including private cars, will be able to approach and drive through the northern part of the Park from both directions. It is probable, however, that the main traffic will be from the Fourth Division where there is a larger centre of population. It will therefore be important that the National Parks Section is seen to have a presence in that part of the Park.

5.4 Significant effects on the Park

5.4.1 Park Headquarters once the road is completed, Park headquarters should be moved from its temporary location at Long Pala on the Melinau river to a point on or close to the road. It is recommended that a site immediately outside the Park boundary on the Lutut river should be investigated (See Map 7). This would have the advantage that the development of, and inevitable disturbance of the habitat at the site would be outside the Park itself; also it would greatly facilitate the control of traffic and persons entering the Park on the Fourth Division side. If no suitable site can be located here, then a site within the Park (possibly where the road crosses the Mentawai river) should be considered and investigated.

5.4.2 The proposed road will be entirely confined to land type 4 (see 8.1) (Setap Shale and Mentawai drainage) and is situated some distance from the main attractions of the Park - Gunung Mulu itself, Gua Payau and other caves, and the limestone massif generally including the Melinau Gorge. There will be the need of a secondary spur road to provide access within the Park but the alignment of this road will need careful investigation to ensure that damage to the habitat and disturbance of the vegetation and fauna is minimised. The Melinau Gorge, or in the immediate vicinity thereof, is the obvious location for the end of this spur road. This road would allow facilities for visitors being developed and the main tourist centre being orientated around the Gorge.

5.4.3 A second spur road to the temporary Park headquarters at Long Pala on the Melinau river is also recommended. No part of this road would pass through the Park. It would facilitate communications with the southern part of the Park and would enable visitors and tourists to make a round trip from the Melinau Gorge to Long Pala and thence by road to the new Park headquarters situated on the main road. An additional advantage would be the accessibility of the Gua Payau - one of the Park's major attractions. Visitors from Limbang would be able to visit this cave and return the same day.

5.4.4 During the period of this plan the main work concerning the proposed road through the Park will be protective and investigative in nature. Prescriptions covering this are included in Chapter 14.

6 PROPOSED EXTENSION TO THE PARK

6.1 Proposal During the course of the recent R.G.S./Sarawak Government expedition to the Park, that part of the Medalam watershed upriver from Nanga Mentawai falling outside the Park boundaries, was investigated to determine its suitability for inclusion within the Park as a constituted first extension. The whole of this area falls within the Medalam Protected Forest. It was concluded that an extension is to be strongly recommended for the following reasons :

6.2 Justification

6.2.1 The present course of the boundary following the Medalam river creates great difficulties for the management of this sector of the Park. There can, for instance be no effective control of access by river to important and vulnerable areas of lowland forest, including the only example of peat swamp forest in the Park (see para 2.6.4.4). Moreover, unless both banks lie within the Park, there can be no protection of the aquatic fauna (fish etc.) of this important river (2.8.6.2).

6.2.2 Specialist studies of the distribution of plants and animals within the Park have emphasised time and again among many diverse life forms, that the richest and most varied communities occur in the lowland alluvial forest habitat (see sections 2.6, 2.7 and 2.8). Yet in this habitat individuals of many species characteristically exist at very low density. Hence comparatively large areas are required to support populations adequate to ensure survival into the foreseeable future. Although true particularly of the larger vulnerable animals (bear, deer, hornbills, etc.) this consideration also applies to many smaller creatures and to many plants, including the specialised herbaceous groups of high interest. In a significant number of cases it is doubtful if the present comparatively small area of alluvial habitat in the Park, as constituted, is sufficient to conserve self-perpetuating populations. Furthermore, Gunung Mulu is the only National Park so far designated in Sarawak to contain this forest formation. On scientific grounds it is therefore very important that the alluvial forest habitat in the Park should be enlarged by the extension proposed.

6.2.3 The Medalam area of the Park cannot satisfactorily be developed for tourism unless both banks of the river are included in the Park.

6.2.4 The whole of the Medalam watershed is part of the traditional hunting and gathering grounds of the Penan. The destruction or heavy disturbance of the forest as a result of logging, would greatly restrict their activities in this area and put further pressure on the Park itself.

6.2.5 Gunung Buda, a magnificent limestone hill and the most north-easterly part of the Melinau limestone massif, would be included in the proposed extension. Preliminary investigations of the flora indicate that it is significantly different to that on limestone within the Park. Furthermore there are spectacular gorges and possibly caves (not yet investigated) that could be developed as tourist attractions.

6.3 Boundary

6.3.1 The proposed extension is shown on Map 2, and a draft boundary description is as follows :
"Commencing at a point on the true left bank of the Medalam river at Nanga Mentawai, the boundary crosses the Medalam river and follows a series of

cut lines (bearings and distances yet to be determined), in a generally north-easterly direction, to the ridge forming the watershed between the Limbang and Medalam rivers; thence following this watershed in a generally southerly direction to the Fourth/Fifth Divisional boundary; thence in a south-westerly direction along the Divisional boundary to the boundary of the Gunung Mulu National Park; thence in a generally north-westerly direction along the Park boundary to the point of commencement."

6.3.2 It will be noted from the above boundary description that a slight modification to the existing boundary of the Medalam Protected Forest is proposed. The boundary of the proposed extension will start at Nanga Mentawai and not at Nanga Abun. It is recommended that the boundary of the Park starts on both banks of the Mentawai river; the modification will also eliminate from the extension an area of shifting cultivation which is located on the true right bank of the Medalam river between Nanga Abun and Nanga Mentawai.

6.4 Content The proposed extension covers c. 12,500 ha (31,250 acres). The southern half would be formed by the north-eastern slopes of the Mulu massif (land type 1). The limestone hill (land type 2) lies across the centre, to the north of which there is a broad band of alluvium (land type 3) rising to the low hills of the Setap Shale Formation (land type 4). Thus all four land types are represented; (see para. 8.1 for definition of these land types).

6.5 Constitution The fact that the whole of the proposed extension falls within the Medalam Protected Forest should greatly facilitate its constitution as a national park. The procedure for constituting a national park, as laid down in the National Parks Ordinance (Cap. 127), will require to be followed, but it will involve only the change in status of an already constituted Government reserve, rather than the constitution de novo of a national park on State land. As far as is known, there are no farming rights in the Medalam Protected Forest, except perhaps in that small portion, between Nanga Abun and Nanga Mentawai, which is to be excluded from the proposed extension to the Park.

6.6 It is strongly recommended that action be taken as soon as possible to initiate the required legal processes. It is recognised, however, that it will possibly be some time before the extension, if approved, can be incorporated into the Park. Many of the management prescriptions that follow are therefore based on the assumption that the Park Warden's control will at first extend only to the present boundary.

7 MANAGEMENT CONSTRAINTS AND OBJECTIVES

7.1 Period of the Plan

7.1.1 The period affected by the principles laid down in this Plan is open-ended, but for operational convenience this plan covers five years from 1st January, 1980 to 31st December, 1984. Recommendations and notes covering future developments are also included.

7.2 Objectives of management

7.2.1 At present the Park, only recently constituted, is inadequately protected. The primary objective of this first five-year plan must be to introduce measures whereby the concept of the Park itself can be firmly established, and then the flora and fauna contained therein may be adequately protected. Initial measures must be taken to ensure a physical presence of National Parks staff within the Park, and to provide the necessary buildings, transport, communications and infrastructure.

7.2.2 The most significant future development will be the construction of the N.E. link of the Pan-Sarawak Highway from Beluru to Limbang, which will pass through the Park. This road will totally alter the means of access to the Park, although it will not be finished during the period of this plan. Initially temporary buildings, transport and communications will be essential, but long-term development of all facilities, including those for research, visitors, recreation and education must be framed with the road in mind.

<u>7.2.3</u> The following are the full, long-term objectives of management:

<u>7.2.3.1</u> To protect in perpetuity the Park in accordance with National Parks Ordinance and the Wild Life Protection Ordinance, and to maintain the natural diversity of the habitats.

<u>7.2.3.2</u> To conserve the terrestrial and aquatic fauna within the Park and its rivers, and ensure by subsequent management that viable populations are maintained.

<u>7.2.3.3</u> To conserve all elements of the flora and ensure by subsequent management that viable populations and representative associations are maintained.

<u>7.2.3.4</u> To preserve in pristine condition the limestone formations and in particular the whole series of limestone caves.

<u>7.2.3.5</u> To promote and provide facilities for scientific research on all aspects of the Park.

<u>7.2.3.6</u> To oversee the operation of gazetted privileges of the local people and ensure that they do not conflict with the other objectives of management.

<u>7.2.3.7</u> To develop the Park for recreation and tourism.

<u>7.2.3.8</u> To provide opportunities for the Park to be used for educational purposes so that the Park itself and the objectives of management may be better appreciated.

<u>7.2.3.9</u> To publish and disseminate information on the Park so that its scientific, educational and recreational value may be better appreciated both within Malaysia and internationally.

8 RESOURCE MANAGEMENT AND PROTECTION

8.1 Zonation and Park ranges

8.1.1 Land types

8.1.1.1 In this early state of development of the Park, no management zones based on usage or intensity of usage are prescribed. For scientific and management purposes the area of the Park has been subdivided into four land types which are readily recognisable on the ground. Though mainly based on geology and geomorphology the land types embrace the main soil types and are closely related to the distribution of the vegetation formations. Their boundaries are remarkably discrete and are indicated on Map 5. Within each land type secondary units are recognised, based once again largely on geology and geomorphology as well as altitude, which greatly influences the climate and hence the vegetation. The four primary land types are :-

(i)	Gunung Mulu
(ii)	Melinau Limestone
(iii)	Alluvial plain
(iv)	Setap Shale Formation and Mentawai drainage

Brief descriptions of the land types and sub-types follow, though more detailed descriptions will be found under the relevant paragraphs covering geology, geomorphology and topography, soils and vegetation.

8.1.1.2 Gunung Mulu Consisting of a large, strongly dissected mountain on the sandstones and shales of the Mulu Formation rising to an altitude of

2,376 m, with narrow ridges and V-shaped valleys. Soils : red yellow podzolics and skeletals mainly overlain with peat at higher altitudes.
Location : Covering the whole of the mountain of Gunung Mulu and bordering onto mainly karst limestone to the north.
Sub-type (i): Low altitude to 800 m (2,625 ft);
Vegetation : mixed dipterocarp forest.

Sub-type (ii): between 800 m (2,625 ft) and 1,200 m (3,937 ft);
Vegetation : lower montane forest.

Sub-type (iii): Between 1,200 m (3,937 ft) and 2,177 m (7,142 ft);
Vegetation: upper montane forest in which two facies (tall and short) are recognised.

Sub-type (iv): Summit zone: approximately the top 200 m (625 ft) of the mountain;
Vegetation: upper montane forest, summit facies.

8.1.1.3 Melinau Limestone. Typical and spectacular karst limestone of the Melinau Formation with high cliffs, tower blocks, pinnacles, extensive rock outcrops and caves. Soils: very thin and discontinuous skeletal soils, comprising silty or clay loams mixed with limestone gravels, occurring in crevices in the rock and between boulders; mainly silty or clay loams on the scree slopes. Organic matter tends to increase with altitude.
Location: Comprising the mountains of Benarat and Api and the south-westward continuation of the limestone massif to the Park boundary; also the large outlying hills of Berar and Tarikan. The smaller limestone hills,

that cannot be identified on aerial photographs, and small outcrops and boulders are included in the Alluvial Plain. Six land sub-types are recognised:

Sub-type (i): Scree slopes; Short, steep (c. 35 degrees) slopes at base of limestone cliffs, maintaining a limestone scree forest; rather open and composed of few species.

Sub-type (ii): Limestone cliffs of typical cliff vegetation.

Sub-type (iii): Slopes below 800 m (2,625 ft) supporting lowland limestone forest.

Sub-type (iv): Lower montane limestone forest between 800 m (2,625 ft) and 1,200 m (3,937 ft).

Sub-type (v): Upper montane limestone forest, above 1,200 m (3,937 ft).

Sub-type (vi): Limestone caves.

<u>8.1.1.4 Alluvial Plain</u> Limestone or shale bedrock, overlain with recent alluvium of varying thickness, and extensive Quaternary terraces. The topography is flat to gently undulating on alluvium; terraces are mainly flat or slightly sloping, with moderately steep sides. Soils are mainly alluvium and clay, with limited areas of organic soils, on the alluvium; humic podzols occur on the terraces. Extensive alluvial forest is found on alluvium, also locally limited areas of peat swamp forest. Various forms of kerangas forest occur on the terraces.

Location: Runs south-west to north-east through the centre of the Park.

Bounded to the south-east mainly by limestone and to the north-west by the Setap Shale Formation. Three land sub-types are recognised :

Sub-type (i): Alluvial plain with alluvial forest.

Sub-type (ii): Quaternary terraces with kerangas forest.

Sub-type (iii): Peat swamps with peat swamp forest.

<u>8.1.1.5</u> <u>Setap Shale Formations and Mentawai drainage</u>. These low hills of the Setap Shale Formation contain a narrow band of the Belait Formation along the Brunei border. The former geological formation is extensively overlain by Quaternary terraces. Soils: Complex, mainly red-yellow podzolics with podzols occurring on the terraces.
Location: The most northern part of the Park towards the Brunei border lying in the Mentawai drainage. There is a sharp boundary between this land type and the Alluvial plain. Two land sub-types are recognised:

Sub-type (i) : Setap Shale Formation supporting mixed dipterocarp forest in some localities resembling kerangas forest in structure.

Sub-type (ii): Terraces and Belait Formation supporting kerangas forest.

<u>8.1.2</u> . For administrative purposes the Park will be divided into two park ranges:

<u>8.1.2.1</u> The southern range based at Long Pala will cover the following area: The whole of Gunung Mulu up to the watershed of the Medalam river; Gunung Api and the limestone and alluvium south of a line running from the

Melinau Gorge, to the Setap Shale Formation immediately north of the headwaters of the Berar river.

8.1.2.2 The northern range based on Nanga Mentawai cover the remainder of the Park area including the drainage of the Medalam river. Gunung Benarat, Bukit Tarikan and the alluvium north of the line mentioned above, and the whole of the Setap Shale Formation and Mentawai drainage (landtype 4).

8.2 Boundaries and buffer zone

8.2.1 Boundaries

8.2.1.1 Land boundaries. Where the Park boundary consists of cut traces, these must be of adequate size, demarcated, regularly cleared, and frequently patrolled. Cut boundaries are as follows :

Southern Range: From the Tutuh river at Long Langsat to Long Melinau Paku - 3,963m (197 chains).

Northern Range: From Nanga Mentawai to the Brunei border - 3,742m (186 chains).

These boundaries should be 2m (6 ft) broad, with the understorey cleared. All trees less than 30 cm (12ins) diameter must be felled and removed from the boundary trace. Boundary trees within the Park should be marked at visible intervals on that side of the tree that faces out with the Park, with yellow paint at a height of approximately 2m (6 ft). Aluminium plates, as currently used by the Forest Department, marked 'National Park' and with the Park logo (see Figure 6) should be attached to boundary trees at intervals of not more than 100m (5 chains) and at all critical points where the boundary changes direction.

Figure 6 Proposed design for a Park logo.

These latter points should also be marked with permanent belian pegs painted yellow at the top. Boundaries should be cleared annually and the demarcation repaired and maintained as necessary.

8.2.1.2 River boundaries. Along river boundaries where there is frequent or occasional passage of river craft, similar aluminium plates should be attached to trees at visible intervals. The following rivers should be demarcated:

(a) Melinau river and Long Melinau Paku to Long Lutut.

(b) Lutut river upstream from Long Lutut for a distance upstream of approximately 1.5 km (1 mile).

(c) Tutuh river from starting point of boundary trace upstream to Tutuh rapids and for a distance of approximately 0.8 km (0.5 miles) along the rapids.

(d) Medalam river from Nanga Mentawai upstream to a point about 0.8 km (0.5 miles) beyond Bukit Buda.

8.2.1.3 The patrolling of these boundaries will be left to the discretion of the Park Warden. During patrols range officers should ensure that the aluminium plates are still securely attached to trees and visible. The remaining relatively inaccessible boundaries in localities which are presently uninhabited do not require to be demarcated or patrolled unless there is any likelihood of incursions into the Park or some illegal activity. The Park Warden must keep the situation under constant review and take action as necessary.

8.2.1.4 Large conspicuous notice boards marked as in Figure 6 with the proposed Park logo should be posted along rivers at points of entry into the Park : Long Melinau Paku, Tutuh river and Nanga Mentawai.

8.2.2 Buffer zones

8.2.2.1 It is strongly recommended that a buffer zone not less than 400m (20 chains) broad is established around the Park and especially in those locations where cultivation (settled or shifting) or commercial timber harvesting is likely to occur. The localities threathened, or likely to be threatened, during the course of this plan are :

8.2.2.1.1 Southern Range

(i) True right bank of the Melinau and Lutut rivers. A forest licencee is harvesting the forest in this locality, but at some distance from the Park boundary. The Director of Forests has approved the establishment of a

40 chains (800 m) buffer zone in which no trees may be felled by the licencee. Furthermore the licencee is not permitted to extract through the buffer zone to the Melinau river.

(ii) From the Tutuh river to Long Melinau following the boundary trace. Primary forest within 20 chains of the boundary should be retained and the local peoples should not be permitted to fell it in order to cultivate the land. The local peoples should be discouraged, if possible, from felling secondary forest, over which they may have customary rights, in the same locality. There is little or no threat from commercial forest exploitation in this locality.

(iii) True left bank of the Tutuh river from Long Ubung to the base of the Tutuh rapids. This area falls within the Melana Protected Forest and is therefore protected against felling for cultivation. However, a forest licence has been issued and commercial timber exploitation is likely to start in the near future. The preservation of the magnificent scenery along the length of the rapids is strongly recommended. A buffer zone here of 40 chains as a complete prohibition on the use of the Tutuh river in this locality as an extraction route for logs (if this is in fact practicable), is fully justified and strongly recommended.

8.2.2.1.2 Northern Range

(i) True right bank of the Medalam river upstream from Nanga Mentawei. It is recommended that an extension to the Park should be constituted covering the headwaters of the Medalam river, inclusive of all the land on the true right bank of the river upstream from Nanga Mentawai (see chap. 6). This area falls at present within the Medalam Protected Forest and is therefore protected against cultivation If the proposed extension is not approved, then a buffer zone along the length of the Medalam river would be essential.

(d) Medalam river from Nanga Mentawai upstream to a point about 0.8 km (0.5 miles) beyond Bukit Buda.

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(ii) From Nanga Mentawai to the Brunei border following the cut trace. The threat in this locality is from forest clearance by people of the Medalam for shifting cultivation. Within at least 400 m (20 chains) of the boundary trace, this should be prevented.

8.2.2.2 Any buffer zones created have no legal status *per se*. The National Parks Ordinance will not apply in these areas, and consequently there is no restriction on hunting, except of those animals protected by the Wild Life Protection Ordinance. (None of the species listed in Schedule 1 has as yet been recorded in the Park). In accordance with forest licencee agreements, the Director of Forests may exercise control over felling areas and extraction routes. Control over shifting cultivation is in theory exercised by the prohibition of felling high forest for this purpose, unless the approval of the local Administration has been obtained. Regular patrol (see para 8.7) to monitor the effectiveness of the buffer zone is essential.

8.3 Habitat Management

8.3.1 General

8.3.1.1 Acts prohibited (unless permission is obtained) in a National Park are clearly specified in Section 14 of the National Parks Ordinance (Chap. 127) (Appendix XVI). This section of the Ordinance should be strictly applied to all visitors. The effects of privilege holders in the Park and prescriptions concerning these are dealt with in paragraph 8.6. General prescriptions related to the protection of the habitat, particularly concerning the development of the Park for visitors, are considered here.

<u>8.3.1.2 Disposal of rubbish</u>. Prescriptions regarding the disposal of rubbish are included in paragraph 12.2.5. The general cleanliness of the Park should be continually maintained. Any litter left in the vicinity of Park headquarters, Rangers' posts, visitor accommodation and shelters and along paths and rivers - in fact throughout the Park - must be collected and disposed of. The Warden must ensure that at all times the facilities of the Park are maintained and kept thoroughly clean. The state of toilets will be of particular concern to the ordinary visitor.

<u>8.3.1.3 Use of local building materials in the Park</u>. The development of the Park to provide facilities for visitors is prescribed in chapters 9 and 12. In the construction and maintenance of such facilities as paths, camp shelters and bridges, constructional materials, especially timber, will be required. The natural inclination will be to use the first timbers to hand but such mainly non-durable, untreated 'green' timbers are likely to rot rapidly and become totally unserviceable within twelve to eighteen months; further repairs and maintenance will then be required. As a general principle durable timbers, such as belian or selangan batu, chemically impregnated timbers, or appropriate substitutes must be brought in even though the porterage of such material will be difficult and expensive.

<u>8.3.1.4 Cooking fires</u>. The lighting of fires must be prohibited. At old camp sites on certain parts of the path to the summit of Gunung Mulu, notably in lower and upper montane forest, the forest has become noticeably depleted of trees, such as <u>Tristania</u>, that provide good firewood. Kerosene must be issued to all visitors who make use of the shelters in the Park and cookers in working order must be provided. Containers on loan should be provided, and the kerosene must also be adequate for the use of all accompanying guides and porters for cooking and lighting.

8.3.2 Vegetation

8.3.2.1 Active intervention in controlling or altering the vegetation will not be a feature of habitat management in the Park. The Park at present is largely covered in climax vegetation, recognisable as self-perpetuating forest types. The main consideration must therefore be protective management to ensure the survival of these diverse habitats in their present condition. Special cases for limited areas of altered, artifical planted vegetation for the benefit of specified animals are mentioned in paras 8.4.2.10 & 11.

8.3.2.2 Ordinary visitors should not be permitted to carry into the Park bush knives (parang) or other similar cutting instruments. Paths should be kept cleared and well demarcated at all times (para. 12.4.5) so that there should normally be no necessity to clear or cut a track. Rangers and guides accompanying visitors will carry bush knives and other equipment needed to deal with single tree-falls, etc, that can be expected on any part of the paths at any time during a trek. The cutting of vegetation or collection of flowers or fruit must be strictly prohibited, unless specific permission for research is given (see App. XVII). This regulation is particularly important in montane forest both on Gunung Mulu and on the limestone. Many species here, such as the pitcher plants, rhododendrons, and orchids, are particularly attractive to visitors. In the main, these plants are slow growing so that frequent or even occasional collection of them by visitors will have marked effect and in addition to disturbing a fragile habitat, may lead to the extinction of the less common species in the Park. Particular care should also be taken to avoid disturbance of the flora on the rocks and cliffs at the base of the limestone hills and at the mouths of caves. Plant species of this habitat are very localized and some are endemic to the Park.

8.3.2.3 Though a good deal of research on the ecology and botany has already been undertaken, the Park will remain indefinitely a source of scientific interest and will continue to attract scientific visitors. They should be encouraged but they must be required to comply with all regulations that the Head, National Parks Section, lays down. Collecting of plants should be for a specific purpose and specialists should not collect in the vicinity of camps or within 10 m (33 ft) of demarcated paths. Only in exceptional circumstances should collecting be permitted in upper montane forest. Tree climbers should be used to obtain specimens from the upper canopy.

8.3.3 Specific prescriptions related to land types

8.3.3.1 Land type 1 - Gunung Mulu. The steep (gradients frequently exceed 45°) dissected terrain on the slopes of Gunung Mulu is very liable to erosion. Natural landslips - evident on aerial photographs - are of occasional occurrence and a feature of the land type. Particular care must be taken in the construction of paths, camps, shelters, look-out points, etc that the natural instability of the land is not further aggravated resulting in erosion. The upper montane and summit zones are extremely fragile and liable to damage. The frequent passage of visitors trampling the spongy peaty surface results in compaction and the exposure of the easily eroded skeletal soil beneath. On steeper slopes, where visitors need to scramble, using hand holds on roots and branches, the situation is liable to be exacerbated. Ladders on the steeper slopes, small platforms or walkways at central points on the flat or moderate terrain, must be constructed. It is essential that suitable (hardwood) timber or prefabricated metal structures be carried in for this purpose. Light-weight aluminium ladders will often be found cheap and effective as climbing aids, the bases of walkways or platforms, etc., and may be preferred to timber products.

8.3.3.2 Land type 2 - Limestone

8.3.3.2.1 The smooth knife-edge karst limestone is a particular feature of the Park. Though the pinnacles on Gunung Api are the outstanding example it may be admired in miniature form at all altitudes. It is, however, somewhat fragile and liable to be broken. Also, the vegetation in many of the micro-habitats is extremely delicate. The path to the pinnacles requires especial care, and ladders, ropes and walkways should be fixed in position wherever damage is liable to occur. Such constructions may also be necessary for the safety of visitors.

8.3.3.2.2 The defacement of rock surfaces by chipping, cutting, writing or drawing must be prohibited and action must be taken against offenders. Limestone cliffs and cave walls invariably have a strong attraction to the name-writer and scribbler. It must be made quite clear to all visitors and to the local people that such action is prohibited. Authorised guides must be instructed to act promptly and firmly to control visitors in this respect. Any defacement or damage caused should be eradicated as far as possible.

8.3.3.3 Land type 3 - Alluvial plain

8.3.3.3.1 Special features of the alluvial habitat reflect its flat aspect and poor drainage. Sections of the paths are liable to become quagmires as the result of frequent trampling and soil compaction. Visitors and local people tend to avoid these by cutting further tracks to bypass them, extending the disturbance in the process. Narrow walkways should be constructed at low-lying points and bridges built over small streams. Again, aluminium ladders are likely to provide useful constructional aids.

8.3.3.3.2 None of the existing or scheduled trails within the Park cross the Quaternary terraces on which kerangas forest occurs. Protective measures will be required when the road is constructed (see chaps 5 & 14). Total clearance of the vegetation on the terrace should be avoided whenever possible. This will expose the infertile podzolic soils on which secondary forest is difficult to establish.

8.3.3.4 Land type 4 - Setap Shale Formation and Mentawai drainage

No trails traverse this land type and development will be confined to the future road construction (see chap. 14). Very extensive terraces occur and will require especial protective measures (see above).

8.3.4 Caves

8.3.4.1 The potential for developing the caves is given in para 9.10. All routes into or through cave systems must be well demarcated and fragile areas protected by barriers or walkways and ladders. All materials for this must be brought in and the use of light-weight aluminium should be considered.

8.3.4.2 Workmen constructing the above or laying cables for lighting, etc should be under strict supervision of a member of the National Parks staff who has been fully briefed with the layout of the important areas of the cave. Specialist consultation is recommended in this respect.

8.3.4.3 The aquatic systems within the caves are frequently biologically rich and no pollution eg. cigarette buts, food scraps must be allowed to occur in the static pools. Spent carbide if used for lighting must be carried out of the cave and not deposited within.

8.4 Wildlife management

8.4.1 Aquatic animals

8.4.1.1 During the R.G.S./Sarawak Government expedition, it was possible to make no more than a preliminary investigation of the aquatic fauna of the Park other than amphibians. Further collecting and research are required as a matter of priority (chap 11). Reference has already been made to the potential importance of the fishes of Park rivers as natural reserve populations for restocking the Tutuh-Baram and Medalam-Limbang catchments (para 2.8.6.) For both purposes it is essential that existing fish faunas (and the equally important invertebrate animals on which many of the fish feed) should be firmly protected from environmental disturbance and over-exploitation. Limited development of angling for recreation is not incompatible with this aim, and can be permitted.

8.4.1.2 The use of the poison tuba (derris root) or synthetic analogues has widespread and long-lasting effects on whole communities of fish and their invertebrate prey. Regulations prohibiting tuba-fishing must be enforced rigorously. Mass-trapping by weir (belat) or long net (pukat) can lead to over-exploitation, and must also be prevented. Small fish traps can be permitted to authorised persons under appropriate control.

8.4.1.3 Significant pollution of the aquatic environment, with adverse effect on the fauna, could occur as a consequence of the introduction of human sewage or other effluents. All permanent housing or much-frequented camp sites must therefore be provided with modern water closets with septic tank systems (which will require regular maintenance) or at least with sound earth-closets situated at least 150 m from any stream. Moreover, senior Park officers must ensure these closets are used by all staff, casual labour and visitors.

8.4.1.4 Soaps, detergents and food waste, as far as possible, should also be kept out of the streams. This requires the provision of interior water supplies, bathing facilities, sinks and drains, coupled with adequate soak-away systems, in all housing for staff and visitors and at all fixed camps. To avoid over-burdening septic tanks, waste water of this type need not be combined with toilet effluent.

8.4.1.5 Serious local degradation of the aquatic environment will be threatened by the road-building scheme. Disturbance of the soil by heavy plant will inevitably increase significantly the solid matter and dissolved solute load of waterways along the construction line. Specialised clear-water life forms are likely to be very susceptible. There will also be the probability of large influxes of labourers whose camps and whose personal behaviour must be subjected to the same rigorous standards of hygiene expected of Park housing and Park staff. It would be a distinct advantage on these counts if the road engineers can agree not to establish quarry sites, labour lines or equipment parks along the sector of the road that lies within the Park (see chap. 14).

8.4.1.6 During the first stage of this plan, further research into the aquatic fauna (particularly fish, but not excluding invertebrates) should be encouraged whenever specialist investigators become available. Interest by Park staff should be encouraged and any man proving enthusiastic and able should be given basic instruction in fish taxonomy.

8.4.1.7 If suitable fish species are found, it will be reasonable to decide to promote sport-fishing as one of the Park's recreational activities. Potentially suitable waters exist in the lower reaches of the rivers on both the northern and southern sides. It is, however, likely that positive management action, including bank maintenance and log-clearance, will be needed to improve selected river pools from an angling aspect. Artificial stocking is not desirable and should not be considered unless use is made of native fish species known already to be present in the Park. The response to fly tackle by fish of the open, gravelly pools of the upper Melinau should be tested. If they prove susceptible, a new dimension would be added to sport-angling in the Park.

8.4.1.8 In the initial stages of Park development, those anglers who wish to do so should be allowed to keep and eat their catch. At the same time, a central gamebook or register should be kept in the Park HQ or main visitors' lodge. In this should be noted the identity, weight, length (snout to tail-base), date of catch, name of angler and any general comments (eg. condition of fish, bait used, etc.) Such a register will serve firstly to increase visitors' interest and secondly (and more importantly) to monitor the effect of angling on fish stocks. If, in the course of time, it appears that any fish species regularly caught is declining in size or becoming rare, then conservation action will be needed. Notes on breeding condition will be valuable if management needs appear to include the imposition of a local close season. Aids to identification, such as the existing wall charts and coloured photographs should be displayed in the visitors lodge. (See para 9.8.2).

8.4.1.9 'Frogging' i.e. searching streamsides, pools or other damp areas by night with the use of a headlamp, is an excellent recreational activity and should be encouraged among visitors. They should not, however, be allowed to kill any frogs for eating. There is likely to be considerable demand to be allowed to do so, especially from Malaysians and other local visitors, when the Rana macrodon group is concerned. This must be resisted, and any frog caught by staff or visitors must be released alive and uninjured at the site of capture, unless taken for authorised research.

8.4.1.10 Of other aquatic fauna, molluscs, prawns and turtles (particularly the soft-shelled turtles, Trionychidae) will be subject to potential hunting pressure from staff and visitors. While a limited cull would probably be sustainable, this is difficult to monitor. It is undoubtedly preferable to preserve natural populations, controlled by natural processes, and to prevent the taking of any members of these groups other than for research purposes.

8.4.1.11 It is recognised that it will not be easy to control the harvesting of aquatic animals with the Park. It will be essential to stress to Park staff, in particular, the importance of maintaining natural population levels and protecting the more aged, larger and therefore more spectacular examples of each group of animals. Because it will be their natural inclination to take fish for their protein source as a matter of course, persuasion and a high degree of motivation will be needed, and a degree of self-denial will be involved. As a corollary, it will be vital to ensure that resident Park staff are adequately victualled with fresh and preserved foods brought in from outside. They must not expect to be self-sufficient with respect to fish, shellfish and other aquatic meats during their Park tours of duty. Similarly it must be ensured that visitors on extended treks in the Park, and scientists engaged in research, are properly provided with rations so as not to depend on wildlife resources.

Peninsular Malaysia (and elsewhere in the Malesian region) it has been thought necessary to protect certain species with the force of law. None the less, at this stage of the Park's development, it is unnecessary to prohibit controlled collection of these butterflies - or of any other invertebrate group - by genuine enthusiasts for their own purposes.

8.4.2.2 Undoubtedly, for the great majority of terrestrial animals of the Park, conservation can best be ensured by the perpetuation of existing habitats in their present extent and diversity. Yet it must always be remembered that populations of many species exist only at low density. Large areas of suitable habitat are therefore required to support viable, self-perpetuating natural communities.
Since, among most groups present in the Park, the richest assemblage of species occurs in forests of the alluvium particular importance is attached to the proposed north eastern extension which will include a significant area of this habitat in the upper Medalam (chap. 6).

8.4.2.3 The extent to which insecticides represent dangerous environmental poisons, to be excluded from the Park, is debatable. To prevent termite attack it is clearly imperative that in every Park building all constructional timber in contact with the ground should be chemically impregnated by an approved treatment method. On the other hand it is not desirable that insecticides should be used routinely if good planning can prevent the necessity. For instance, in the alluvial habitat, to avoid the annoyance of the bites of ceratopogonid midges (2.9.7) all residential accommodation should be sited at a sufficient distance from river banks to be outside their flying range. To exclude mosquitoes, the sleeping rooms of all personnel (not merely those of visitors) should be screened, and continual attention must be paid by resident staff to the elimination

8.4.1.12 Finally, it cannot be overstressed that the aquatic animals of the caves and underground rivers include species of especial interest and importance. All must be regarded as very strictly protected (see para 8.3.4). While visitors should be encouraged to observe the behaviour of these animals, disturbance should be kept to a minimum and collecting permits should be issued only to bonafide research workers.

8.4.2 Terrestrial animals

8.4.2.1 Coverage of the different groups of terrestrial vertebrates and invertebrates during the recent expedition was uneven (chap. 11; App. XX). It is likely that further observations by staff or by informed visitors will soon add species to the vertebrate list. For certain vertebrate groups (eg bats, snakes) collection of small numbers of specimens will be required to confirm identification, but for others (notably the birds) sight records should generally be adequate; permission to collect in any case should only be given for recognised scientific research. Hunting of big or small game by any persons, other than those holding the privilege to do so in prescribed areas, must be rigorously prohibited. No Park staff and no visitor should be permitted to kill any terrestrial vertebrate animal for sport or food. In the long term some management-oriented research will be required for certain species; urgent cases are considered below (8.4.2.7) For invertebrates, by contrast, it will be a long time before even the R.G.S. material can be fully sorted and reviewed and the scope for further study is limitless. It is likely that initially the Lepidoptera will be foremost in attracting visitor interest, including the wish to collect. There is a commercial market for brightly coloured butterflies which can lead to over-collecting, to the detriment of local populations. The birdwingc and swallowtails (Papilionidae) in particular are avidly sought, and in oi potential breeding sites (i.e., any small body of water) around housing. The alternative - a regular programme of spraying with persistent insecticide - should not be considered. Negotiations on this subject may have to be carried out with the health authority (anti-malarial campaign), but there is no doubt that prophylaxis by drugs coupled with the physical control of mosquitoes is ecologically (and perhaps also economically) preferable to the introduction of large quantities of persistent insecticide into the Park environment.

8.4.2.4 Insecticides in bulk are also lethal to vertebrates, but it is unlikely that any Park staff or visitor will consider their use for this purpose - which should obviously be banned. It is possible that future forestry management plans will include proposal for poison girdling. As is well known, sodium arsenite has (apparently by virtue of a salty taste) a fatal attraction for mammals. Its use in forestry practice or as a general weedkiller should not be countenanced within the Park.

8.4.2.5 The road building programme is unlikely to have any direct serious ill effects on the overall Park populations of small terrestrial animals. There is, however, a great danger that outside construction labourers will engage in illegal hunting of larger mammals. Moreover, it is only reasonable to expect that the roadworks will draw casual or part-time labour from local communities, some of whom may have traditional privileges allowed in the Park ordinances. Hunting activity by such men will be potentially difficult to control. There are thus further strong grounds for seeking agreement with J.K.R. that, during the construction of the road, no quarry sites, vehicle parks or labour lines are located on that part of the road passing through the Park (cf. 8.4.1.5). It is imperative that ranger posts should be established at the points where the road crosses

the Park boundaries as promptly as possible, i.e. as soon as foot-traffic can pass and long before the road is open to wheeled traffic. It will be necessary to man these posts continually, and to ensure that all persons entering the Park are aware of the regulations controlling hunting.

8.4.2.6 It must also be recognised that the disturbed soil alongside the road trace will be colonised initially by characteristic secondary vegetation. This will permit entry into the Park of the associated animal species (of which certain birds are conspicuous members) at present confined to limited areas of the river banks, gaps formed by tree fall, etc. These invasions will have local effects on the pattern of animal distribution. They will, however, also add to the diversity of the Park fauna and for this reason need not be considered wholly unwelcome.

8.4.2.7 As already mentioned, (8.4.2.1) the invertebrate animals of the Park will continue to attract scientific research workers for many years into the foreseeable future. At the present stage of development there appear to be no particular research projects in this field that need to be promoted urgently in the interests of Park management. None the less, to ensure world-wide knowledge of and support for the Park and its concepts, facilities should always be freely offered without time limits to specialists in invertebrate groups wanting to carry out investigations in the Park. Encouragement should be given equally to amateurs making short visits to the Park. Both types of visitor should be permitted to collect. At the same time policy requires that the numbers collected of any one species should be kept within limits, and in particular that large and attractive butterflies should not be exploited for commercial reasons (cf. 8.4.2.1) It is therefore desirable to control collection by permit. A suitable form (as given in Appendix XVII) will include the requirement that, before departing from the Park, the permit holder should complete and hand in a return section itemising his collection, which can if necessary be subject to verification by Park staff. For the time being, an upper limit of five individuals of any animal species should be imposed; populations will need to be monitored and this figure adjusted if cause for concern arises. While the control of collection by these means is considered desirable, the process should not become oppressive to the extent that the amateur collector is deterred. Thus permits should be issued with the minimum of bureaucratic control and not unreasonably withheld.

8.4.2.8 Among vertebrates, as has already been noted, the gibbons and the leaf monkeys were found during the recent expedition of 1977-78 to have restricted ranges within the Park. Their absence from apparently suitable habitat, e.g. in the lower Melinau Paku, where frequentation by man was comparatively intensive, and - for leaf monkeys - the small size of their troops throughout the Park, suggest excessive cropping. Apart from man, they have no carnivorous predators; if present, the clouded leopard (Neofelis nebulosa) is unlikely to take a significant toll. Under natural circumstances, populations of these gregarious, territorial, leaf and fruit eating mammals are presumably controlled by a combination of factors including social behaviour, food resources, parasites and disease-causing micro-organisms. During the R.G.S. expedition a skilled and able Penan blowpipe user demonstrated that he was able to select positively the species, sex and general age (i.e. adult vs. juvenile) of leaf monkey quarry. Given this expertise among the hunters there is little doubt that, if it was judged desirable, the Park populations of these large primates could be managed to produce a sustainable yield of meat for human consumption. Different sources available to us conflict on the numbers of Penan at present regularly using the Park, and on the quantities and varieties of animal meat that they habitually take over periods longer than one or two sample days. The extent to which the Penan are cropping leaf monkeys partly or wholly in search for bezoar stones (batu geliga) is also unknown. Because the gibbons and monkeys are potentially high in attractiveness to visitors, are important as subjects of scientific research and are generally decreasing and threatened throughout their range over the whole of Borneo these aspects of their biology and their interactions with man in the Park need to be the subject of urgent research. The field of primatology in general attracts funds, and it should not be impossible to find both the finance and also a suitable post-graduate candidate. It is likely that the right person will come from overseas. Application to appropriate funding bodies and research institutions should be made for at least one member of Park staff (or successive individuals in turn) to be attached to the project and for the scientist selected to spend an agreed proportion of his time in training National Parks and Wildlife personnel in general research methods.

8.4.2.9 Ground mammal species identified as hunting quarry of Penan in the Park are porcupines, mouse-deer, sambhur and bearded pig. It appears that among these only pigs are taken in sufficient number to be of concern in management planning. Pigs are also the principal ground quarry sought by hunters of the settled villages exercising their gazetted privileges within the Park. Analysis of the pig jaws from Long Iman demonstrates that, using traditional weapons, the Penan of this community are highly discriminatory with regard to the age (but not with regard to sex) of the pigs they select; no doubt, if they had reason to do so, they could also discriminate between the sexes. Once again, their skill as hunters would make possible a programme of planned, rational cull related to potential productivity of the pig population within the Park. No comparable study has been made of the hunting habits of other communities, but general experience indicates that, using shotguns, they tend frequently to kill the first animal encountered, regardless of age or sex. There are thus two different factors in operation against the pigs. It is important that research on lines similar to those proposed for aboreal primates (8.4.2.7) should be undertaken. The bearded pig is, however, considerably more fecund than the gibbon or monkeys, and (although undoubtedly gravely reduced in numbers over much of Sarawak by excessive hunting) not actually threatened. From an international viewpoint, conservation-oriented research might appear less pressing. In the first instance, it is probably preferable to concentrate on the more urgent topic, regarding the pigs as a subsidiary element in the investigation. A provisional outline research programme incorporating these ideas, suitable as a basis for grant application, is attached as Appendix XVIII.

8.4.2.10 Still, it must not be forgotten that bearded pigs are the chief and the only common large ground animal in the Park. Their pale colour when full grown is unusual among the pigs. Foreign visitors unfamiliar with local wildlife are invariably astonished and excited by their first encounters with pigs in the Park. Park management should therefore aim to maintain the pig population at a high enough level to ensure that every visitor sees one (or more). In the later stages of Park development, consideration should be given to artificial means of attracting pigs (and other hoofed game) to selected sites, not excluding the planting of appropriate crop plants (e.g. tapioca) and fruit trees, and the provision of mineral licks. A high hide for visitors could be erected at a suitable spot overlooking such an area, which should be centrally located within the Park on alluvial soil, reasonably close to the ultimate site of Park Headquarters.

8.4.2.11 A similar policy of artificial enrichment of the environment could also be applied to attract important, colourful fruit-eating species (notably the hornbills, pigeons and many other birds, and squirrels) to chosen areas where facilities for visitors would be arranged. As far as possible, such a scheme should rely on the propagation or encouragement of naturally occurring fruit trees, among which the figs (*Ficus* spp.) are by far the most important; cultivated fruit trees might also be planted. Research into the fruiting periodicity of figs in the Park is needed to provide requisite background information.

8.4.2.12 It is strongly recommended that efforts to increase the wildlife attractions of the Park to visitors, at this stage, should be confined to resource improvent (such as that outlined above, 8.4.2.8-9). No attempts should be made to add to the naturally occurring fauna by the release of additional animals. In particular, the Park should not be used as a site for schemes to rehabilitate or reintroduce to the wild any animals formerly in captivity. There are two scientific reasons for this prohibition; firstly, captive animals are very liable to be infected with parasites or diseases not normally encountered in the wild, to which wild populations may therefore be highly susceptible; and secondly it is important not to alter the existing genetic structure of Park populations. It is, of course, also common experience that formerly captive wild animals lack the fear of man and can therefore be obstreperous or actually dangerous.

8.4.2.13 The one species not now present in the Park that, in future plans, might be considered for reintroduction is the banteng or temadau (*Bos javanicus*). The banteng is severely threatened as a wild animal throughout its range, and since records existed has declined catastrophically within Sarawak. The evidence of Spenser St. John (para 2.8.2) indicates that in the last century banteng were found in the vicinity of the Park. The upper reaches of the S. Melinau (e.g. in the Pulau area) appear to provide adequate habitat to support a small herd. If wild stock were to become available, this would be a possible site for release - always provided that close supervision and informed management were possible. Such a project would involve international conservation interests, and could attract useful funds for the benefit of the Park.

8.4.2.14 Finally, once again, for the terrestrial species of animals as well as the aquatic (8.4.1.12), it is important to stress the vulnerability of cave faunas. The existence of the troglodyte community, consisting chiefly of invertebrates, is ultimately dependent on the presence of the vertebrates which fly outside the cave to feed, i.e. the bats and swiftlets. Roosting bats, in particular, are very susceptible to disturbance and excessive interference will cause them to leave one cave in favour of another. During the period of lactation (often seasonal among insect-eating bats, the Microchiroptera), such disturbance can have severe effects, resulting in population decline. The frequency with which caves are visited and the behaviour of visitors both therefore require to be controlled very carefully. The emerging flight stream of wrinkle-lipped bats from Deer Cave takes a route that is probably high enough to be largely immune from disturbance. It should still be a matter of priority to build a viewing shelter in which visitors will be partially concealed (para. 9.6). The artificial illumination which will be required for overnight visitors to this shelter should be of moderate to low intensity, and should be prevented as far as possible from shining outside the building. Except for very short-term occasions (e.g., filming, TV) no generator should be used in the cave.

8.5 Regulation of privileges

8.5.1 General

The most difficult problem concerning the management of the Park is the regulation, or overseeing, of the privileges of the local people. The protection of the Park itself, and the fauna and flora therein, must be the primary consideration; yet at the same time the gazetted privileges of the local people must be respected. It is inevitable that these people are liable to see the constitution of this Park (or of any other Government reserve) in a negative light; something that impinges upon their traditional way of life. Every effort needs to be made, through consultation, education and by other means to assist these people to appreciate the Park, not only as a conservation area, but as something of direct value to themselves. Already, mainly as a result of the recent R.G.S./Sarawak Government expedition, the attitude of the inhabitants of Long Terawan has undergone a change. The cash gained from employment enabled many of them to purchase timber and other materials for the rebuilding of their apartments in the new longhouse. They can foresee that in the future an increase of visitors to the Park may provide them with steady employment and cash income. To a limited extent they are already appreciative of the value of the Park as a conservation area for wildlife. It is likely that as the Park is better controlled (and illegal entrants and offences prosecuted), legitimate privilege holders will appreciate the importance of their privileges and ensure that they are not abused.

8.5.2 Preliminary measures

8.5.2.1 Since the Park was constituted in 1974, few positive protective measures have been taken. The local people, though now familiar with the

existence of the Park, are generally unaware of its nature or of the limitations of their privileges. Privileges have been abused and people without legitimate privileges have made use of the Park. Some preliminary measures must be taken even before Park Rangers are established in the Park and patrolling is undertaken.

8.5.2.2 It is essential, firstly, that a census is taken of privilege holders. The Head, National Parks Section, should arrange to undertake this and the cooperation of the district officers, Baram and Limbang, should be sought, making use of the register of the population of each longhouse maintained in district offices. National Parks' officers should visit all longhouses that have privileges and prepare a register of the adult male population. Identity card numbers must be recorded. This register should then be checked against data in the district offices and any discrepancies clarified. With regard to the Penan population, both nomadic and semi-settled, the assistance of the Curator, Sarawak Museum, should be sought. The previous work of the Government Ethnologist (Kedit 1978) will serve as a sound basis for a census of the Penan. Copies of the completed census should be kept by the Warden and at the Northern range post, and in the headquarters office in Kuching. Additional copies should be sent to the District offices of Baram and Limbang. It is essential that the census is kept up to date by adding annually the names of youths attaining adulthood or head of family status and by deleting the names of deceased privilege holders at the time of the notification of death.

8.5.2.3 During any visits to longhouses National Parks' officers should take every opportunity to explain the nature of the Park as well as the precise gazetted privileges to the inhabitants. Copies of a map of the Park, showing the boundaries of areas where privileges may be enjoyed,

together with written description (in Malay and in the local language) of the privileges, should be posted in each longhouse, and made freely available to Tua[2] Kampung or Tuai rumah for distribution to their villages.

8.5.3 Control of privileges

8.5.3.1 There is no provision in the legal Gazette notification, detailing the privileges of the local people, for the control or management of such privileges. Furthermore, though the Director of Forests may make regulations for carrying out the provisions of the National Parks Ordinance (Cap. 127), say in accordance with Section 19(i) of that ordinance, the approval of the Governor in Council is required for such regulations. The Head, National Parks Section, should carefully review the situation in the Park during the course of this plan with a view to the preparation of specific regulations concerning the control of privileges for submission to the Director of Forests and approval by the Governor in Council. Regulations that might be considered include the following :

(i) The prohibition on the hunting of either deer or pig (the only animals permitted to be hunted) for a period of time.

(ii) The closure of part of the Park for a definite or indefinite period to enable the population of certain animals (deer or pig) or plants to increase. Some such regulation may well be desirable in localities most frequented by visitors.

(iii) The prohibition on the gathering of certain plants for a period of time. There is a liability that certain palms, in particular those that are monopodial, may be over-cropped.

(iv) The total prohibition on the use of certain weapons, traps, nets etc. for the hunting of animals and birds and catching of fish. Some regulation on the type, and size of mesh, of fishing nets will surely be required.

8.5.3.2 One important step can be taken immediately to curtail excessive hunting by privilege persons. As a condition of any paid employment within the Park no person, without the permission of the Warden, should enjoy his legal privileges. This regulation, which would require no higher approval, if imposed as a condition of employment, could in due course be of importance when the numbers of visitors to the Park increases. It would affect all permanent staff labourers and porters and all temporary guides. The corollary already noted in Section 8.4.1, is that steps must be taken to ensure that all temporary employees and permanent staff in the Park are at all times adequately rationed with preserved foods. Considering the remoteness of the area, it may be necessary for the Park Warden to keep stores of tinned fish, etc., for resale to employees, or for the Warden to permit some suitable person (e.g. a Ranger's wife) to run a small general goods store on a commercial basis. Such a shop cannot be considered until the road connection exists but thereafter could provide a useful incentive to keep staff in the Park.

8.5.3.3 The privileges of inhabitants of the longhouses in the Tutuh and Medalam rivers should be carefully superintended particularly to ensure that: (i) No person who does not hold legitimate privileges enters the Park to hunt, fish or gather produce. There is probably more danger of this occurring in the northern than in the southern range; in the Tutuh the population of local people is smaller and situated at a greater distance from the Park.

(ii) The legitimate privilege holders confine their activities to the defined areas of the privileges. Here again there is more likelihood of abuse of privileges by the inhabitants of the longhouses in the Medalam river, whose defined area is the drainage of the Mentawai river, but who are known to have hunted in the Medalam drainage and are reported to have crossed into the drainage of the Melinau river.

(iii) The legitimate privilege holders only hunt those animals, i.e. pig and deer, that are permitted and that gathering is restricted to the specified items. It should be noted that the felling of trees and removal of timber for any purpose is not permitted; also that the inhabitants of the longhouses in the Medalam river have no gathering privileges.

8.5.3.4 The inhabitants of the longhouse at Seridan probably make little use of the Park. Furthermore this area of the Park is extremely inaccessible. Though they should not be entirely ignored, low priority is given in the first phase of this plan to investigations into the enjoyment of privileges in this area.

8.5.4 The Penan

8.5.4.1 The Penan population deserve special consideration. At the time the Park was constituted it was realized that their livelihood was to some

8.5.4.4 The reduction of the privileges of the Penan finally to coincide with those of the inhabitants of the longhouses in the Tutuh river (as specified in the Gazette notification) should be gradual, and as far as possible, done with their concurrence. Initially they should be permitted to hunt other game than pig and deer, though they only have the privilege to hunt the latter. The killing of leaf monkeys for the sole purpose of obtaining bezoar stones must, however, be prohibited.

8.5.4.5 As they become settled and hence less dependent on the produce of the Park for their livelihood it is recommended that the reduction of the privileges of the Penan might be gradually implemented as follows:-

(i) Closure of part or parts of the Park, particularly in lowland areas traversed by visitors, to the hunting of the more threatened species, notably monkeys and gibbons.

(ii) Extension of the areas closed to the hunting of specified mammals and birds, and the number of protected species to be increased.

(iii) This process should continue until such time as their privileges are the same as those of the inhabitants of the Tutuh longhouses.

8.5.4.5 No time schedule can possibly be given for the implementation of this process as there are numerous factors outside the control of the Park management involved. It is recommended however that during the period of this plan a start may be made by implementing (i) above in a restricted area, possibly between Long Melinau Paku and the Paku camp.

8.6 Law enforcement The Park Warden and Rangers must be officially appointed to the Park in accordance with the National Parks Ordinance (Chap. 127) so that they may exercise the powers of their office.

8.6.1 It is essential that the Warden and Rangers are thoroughly familiar with those sections of the National Parks Ordinance that directly concern the management of the Park. They should also have a complete understanding of the privileges of the local people.

8.6.2 In accordance with Section 19 (1)(g) of the National Parks Ordinance (Chap. 127) a regulation should be submitted for the approval of the Governor in Council providing powers to compound offences in the Park by the Head, National Park Section.

8.6.3 The Warden and Rangers must be completely familiar with the procedure when offences are detected, including their powers of arrest and procedure when offenders resist arrest or are suspected of giving false information.

8.6.4 It is recommended that offences are normally compounded; the prosecution of offenders in court is liable to cause considerable delay in the settlement of the offences and some inconvenience (production of witnesses, etc.).

8.7 Patrolling

8.7.1 Range Posts Two range posts will be established in the Park at :

(i) Long Pala to cover the southern range;

(ii) Nanga Mentawai to cover the northern range.

<u>8.7.1.1</u> Each post will be manned by two Park Rangers assisted by two labourers. Under normal circumstances one Park Ranger will always be present at the range post.

<u>8.7.2 Patrols</u> The patrolling system is the foundation to protective management of the Park. It is essential that it is competently and efficiently carried out; all illegal activities investigated and subsequently compounded or prosecuted and that statistics and reports are well maintained.

<u>8.7.2.1</u> The main function and duties of the Park Rangers will be to patrol the Park and check the hunting and gathering activities of the local people. The following localities should be given priority :
<u>Southern range</u>: (i) Alluvial plain (land type 3) whole area, (ii) mixed dipterocarp forest (land type 1) extending from base of Tutuh rapids to headwaters of the Melinau Paku river; (iii) Melinau Gorge and mixed dipterocarp forest (land type 1) south and east of the Gorge.
<u>Northern range</u>: (i) Mentawai river to headwaters, concentrating within about 1 km (0.6ml) of the river itself and along the established Penan paths; (ii) Alluvial plain (land type 3) from Medalam river, crossing the Tarikan river to boundary with southern range; (iii) Mixed dipterocarp forest (land type 1) in Medalam river to a point about 5 km (3 ml) upstream of Bukit Buda; (iv) Medalam Protected Forest (if approved as an extension).

<u>8.7.2.2</u> The more inaccessible parts of the Park, including the Tutuh rapids and areas south of the Rapids, the headwaters of the Medalam river and the extreme headwaters of the Mentawai river and tributaries should be patrolled much less frequently, about once a year.

<u>8.7.2.3</u> Normally one Ranger will be on patrol whilst the other remains at the Range post. The patrolling Ranger must always be accompanied by at least one labourer.

<u>8.7.2.4</u> Patrols should not normally follow main trails. At the discretion of the Warden patrol posts should be established at convenient points.

<u>8.7.2.5</u> The patrolling Ranger should investigate the activities of all people in the Park record details of mammals, birds, fish or produce in their possession and determine whether any offence has been committed. They should carry in booklet form a list of all legitimate privilege holders (with identity card numbers.)

<u>8.7.2.6</u> Any person found commiting illegal acts should be immediately accompanied back to the range post for further interrogation and a report submitted to the Warden.

<u>8.7.2.7</u> At the end of each month the senior ranger at each range post should submit a monthly report detailing the results of the month's work, including:

(i) Monthly diary of both Rangers

(ii) Details of numbers of persons passing the range post

(iii) Full details of patrols indicating precise localities visited

(iv) Numbers of persons met on patrols and details of their activities

(v) Full details of all forest offences

(vi) Any evidence of undetected offences

(vii) Details of visitors (northern range only)

(viii) Other information, such as the state of paths, bridges, shelters etc.

9 RECREATION AND TOURISM

9.1 Scope

9.1.1 Gunung Mulu National Park is essentially a wilderness Park and for the first five years of this plan at least access into, and travel within the Park will be, for the average visitor, time consuming and strenuous. Accommodation, although available at the edge and within the Park, will be sparse and of a simple nature compared to the sophisticated lodges or hotels of national parks in (e.g.) East Africa, with which many tourists will be familiar. This point and the long and somewhat arduous, journey to the Park should be made a feature which will attract the right kind of visitor and at the same time not raise expectations beyond the level of actuality.

9.1.2 Whilst access is by river, the main centre of attraction will be the south-western corner of the Park which includes Gua Payau (Deer Cave) and the west ridge of Gunung Mulu. The chief accommodation for visitors will initially be at the Southern Range Quarters (temporary Park headquarters) at Long Pala. Similar temporary accommodation should be built at the Northern Range Quarters at the earliest opportunity, and eventually visitors should be encouraged to approach from the Baram and the Limbang in balanced numbers. The morale and interest of Park staff will be maintained by regular contact with visitors, and the goodwill of local communities will be encouraged as they earn cash as boat men, porters or guides.

9.1.3 The potential of the caves in the Melinau Limestone formation for tourist attraction was assessed in a preliminary survey during the R.G.S., Sarawak Government expedition. Some caves should be included in ordinary visitors' programmes, but specialist training of guides will be a necessary preliminary; comments and reservations appear elsewhere (para. 9.10).

Whilst caves in the northern part of the Park may be discovered and developed in due course, those in the south are likely to remain the chief focus. There is also potential for rock climbing on certain cliffs; development of facilities may be considered for inclusion in future management plans.

9.1.4 The proposed extension of the Pan-Sarawak Highway to Limbang will completely change the means of access to the Park; implications are discussed in Chaps 5 and 14. If the two spur roads proposed in 14.3.2 are constructed enjoyment of the Park will be open to day visitors. The centre for visitor use will be established in the Melinau Gorge area.

9.2 Access and Permits

9.2.1 Until the proposed road is completed, normal access to the Park will be via Marudi up the Tutuh river to the temporary headquarters at Long Pala. Access via Limbang and the Northern Range quarters at Nanga Mentawai, thence up the Medalam and Tarikan rivers to Lubang Cina and the Melinau Gorge will be permitted but not encouraged.

9.2.2 All visitors entering the Park must be in possession of a valid permit which must be sanctioned by the National Parks Section and issued in Miri, Limbang or Marudi. A Park "Code of Conduct" should be produced by the N.P. Section and given to each visitor (see Appendix XIX) and the Warden will be given authority to request a visitor to leave should he/she persistently break this code.

9.2.3 Tour operators must apply for permission for each tour to the Director of Forests, Kuching.

9.3 Transport

9.3.1 It is recommended that the Park authorities should not provide

transport solely for the transport of visitors to and from the Park. Arrangements should be made with reputable persons in Marudi, Limbang and Long Terawan for this purpose. Visitors may be permitted to use National Park's transport, at the agreed charges rate, if this is available and is proceeding to or from the Park on normal duties, but in general outside contractors should be encouraged so long as they provide a reliable service of acceptable standard. Fees should be agreed, and published on all information literature.

9.3.2 Bookings of transport may be made through the National Parks' Section in Miri, Marudi, or Limbang. Visitors may be permitted to make their own transport arrangements but will not be allowed to enter the Park without a written permit (see para. 9.2 above).

9.3.3 Whilst in the Park visitors may be permitted to hire transport together with driver, to proceed up the Melinau river to the confluence with the Lutut river or to go up the Tutuh river to the base of the rapids. The charges for such boat transport should be fixed in advance and subject to biannual review by the Director of Forests.

9.3.4. Approach to the Park by helicopter with use of the helipad at Long Pala should be permitted upon payment of a landing fee which should be fixed in advance and subject to annual review.

9.3.5 On completion of the proposed trunk road, access to the Park will presumably normally be by car, although some visitors may still prefer to make the boat journey. A long-term car park must be constructed at the Park headquarters and at the spur road-head at Long Pala. At the Visitor Centre near the Melinau Gorge (see Map 7) a car park for 20 cars for day visitors should be constructed in the first instance, making allowances for future expansion to 40 spaces in the second phase. This road will open for use by visitors at stated times only, and the Warden's permission will be required

for overnight parking.

9.4 Accommodation

9.4.1 General. The relevant paragraphs in Chapter 12 lay down the principle points concerning the development of accommodation. In general use should be made where possible of pre-constructed modular buildings. Aspects of development of the permanent Park headquarters and Visitor Centre are given in Chapter 14. As stressed in para 8.4.2.3 all constructional timbers in contact with the ground must be pressure-treated against insect attack and decay. Proper water sanitation must be provided at the visitor hostels and centre, and care must be taken to provide for proper disposal of wastes (cf. 8.4.1.3).

9.4.2 Under no circumstances will visitors be permitted to sleep on mattresses or pillows without using bed-sheets and pillow-cases. Visitors may be permitted to bring their own bed sheets and pillow-cases but a minimum of 10 pairs of sheets and 10 pillow-cases should also be purchased and offered for hire at a charge which will cover the laundry costs. The laundry work should be offered to the wife of a resident member of the Park staff, subject to satisfactory performance.

9.4.3 At Long Pala a hostel for 12 visitors will be needed. This should be sited far enough from the river bank to avoid insect problems (cf. para. 8.4.2.3). The requirements of this building are considered in para 12.2.7.1.

9.4.4 At Nanga Mentawai a smaller building should be constructed to house up to 12 visitors, entering from Limbang. When the Park headquarters is established on the main road this accommodation may be used by Park staff.

9.4.5 At permanent Park Headquarters : When these are moved (to the

S. Lutut or S. Mentawai) on completion of the proposed road, the following accommodation will be constructed there:

9.4.5.1 For 20 visitors on similar lines as that at Long Pala (see paras 12.2.1 and 14.3.3.2).

9.4.5.2 In addition, one self-contained, 2 bed-room chalet-type bungalow reserved for V.I.P. (official/government) visitors and one similar bungalow for visiting scientists.

9.4.5.3 A cafeteria and lounge will be provided for overnight and day visitors where meals and snacks/drinks may be purchased.

The standard of food offered will be simple. Tenders should be invited for the contract, and any wife (or wives in combination) of Park staff should be permitted to submit tenders. The acceptance of such tenders will be the responsibility of the Director of Forests.

9.4.5.4 At the end of the spur-road to the Melinau Gorge a Visitor Centre will be constructed (see also 10.2). This will contain shelter and toilet facilities for day visitors to the Centre. Because of the uncertainty of visitor numbers, a cafeteria at this point will not necessarily be viable.

9.4.5.5 For those visitors making long stays, including visiting scientists, private arrangements should be encouraged with the wives of Park staff, if willing, to undertake part-time domestic service. Under such circumstances, all arrangements, will however, require the consent of the Park Warden, who should propose standardised rates of pay and conditions of employment.

9.4.6 Overnight shelters along Park trails and at Gua Payau (see Map 8). The time involved in travelling around the Park trails (see para 9.5 and Table 11) necessitates a number of overnight stops. Some of these are already

established; others are required to be built. The development aspect is dealt with in paras 12.3. Shelters are provided with a minimum of equipment; kerosene, the only form of heating allowed, must be carried in by Park staff and visitors (see para 12.3.1.7).

9.4.6.1 Paku Camp: situated at 150 m (500 ft.) on a tributary of the Melinau Paku as the mixed dipterocarp forest rises out of the alluvial plain.

9.4.6.2 Kapur Camp: situated in majestic dipterocarp forest at 500 m (1600 ft) marking approximately the half-way stage on the ascent of G. Mulu from Long Pala.

9.4.6.3 Summit Camp: situated on the west ridge of G. Mulu at 1800 m (5400 ft) in upper montane forest. There is a helipad just above this site which affords excellent views. The summit of Mulu can be climbed in 1-2 hours from this camp leaving time to return to Kapur shelter the same day.

9.4.6.4 Hidden valley Camp: Situated in the Hulu Air Jernih, (known during the R.G.S./Sarawak Government expedition as Hidden Valley) this should be smaller, where conditions can be somewhat primitive as the shelter will be less frequently used.

9.4.6.5 North-east Camp: This will be located on Trail G (see para.9.5.1) on the north-east ridge of G. Mulu at approximately 1500 m (5000 ft) on the head waters of the Melinau river. This initially because of its location would be a more simple shelter (see para. 12.3.3.3.).

9.4.6.6 Melinau Gorge Camp: Situated in the mouth of the Gorge at 150 m close by the river and a limestone cliff. From here a visit to the Pinnacle region is possible and back in one (long) day. The long-term value of this camp will have to be reviewed when the Visitor Centre is built on the other side of the river.

9.4.6.7 Pinnacles Camp: Situated on the north side of G. Api at 1200 m (4000 ft) in a location from which the limestone pinnacles may be seen to advantage. This should be treated as a day shelter and visitors encouraged to make the journey there and back to the Melinau Gorge Camp in one day.

9.4.6.8 Deer Cave Camp: simple facilities for shelter will be needed at the main mouth of Gua Payau to allow viewing of the emerging bat stream. Care must be taken in construction so that light is largely screened from the cave aspect (para. 8.4.2.14). The shelter should consist of a level floor to allow for up to five people to sleep, if necessary, with bench and table.

9.5 Trails

9.5.1 Location. Seven trails are proposed in this plan; all have been demarcated on the ground by National Parks staff either before or during the recent expedition (see Map 8). The detailed alignment still requires to be marked out in the field for Trails F and G. Walking times between camps on each trail is given in Table 11.

9.5.1.1 Trail A. From Long Pala through alluvial forest in the Melinau Paku valley onto the west ridge of Gunung Mulu and thence via camps Paku and Kapur to the Summit Camp and the top of Mulu.

9.5.1.2 Trail B. A branch off Trail A whilst in the lower reaches of the S. Melinau Paku before Paku Camp is reached, to Gua Payau (Deer Cave).

9.5.1.3 Trail C. From Long Pala following the Melinau river upstream to the Melinau Gorge through alluvial forest. At times of high water and when Park boats are available the stretch between Long Pala and Long Berar may be made by boat. A land trail between this stretch is maintained (at

Table 11 Average walking times between camps on trails in Gunung Mulu National Park. Times in hours.

Camps \ Trails	A	B	C	D	E	F	G
Long Pala							
Paku	2 - 3						
Kapur	1½ - 2		6-8 river			6 - 8	
Hidden Valley	4 - 5						
Summit		1 - 2					
North-east			land 4-6			7 - 10	4-6
Melinau Gorge				3 - 4			7-10
Pinnacles					4 - 6		
Lubang cina Gua Payau							
Colour code	red	red & blue	yellow & red	yellow & blue	yellow	orange	blue

present outside the Park) on the true right bank of the S. Melinau.

9.5.1.5 Trail E. From the Melinau Gorge to the S. Tarikan at Lubang Cina through alluvial forest. The Trail should be maintained along the S. Tarikan to a point where boats can reach from Nanga Mentawai.

9.5.1.6 Trail F. From Long Pala following the route of Trail A to just before Paku Camp following up the Melinau Paku and over a sandstone ridge at 900 m (3000 ft) to drop down to 450 m to Hidden Valley Camp. Thence rising out of the valley (of Sungei Air Jernih) back to the ridge and around the east base of G. Api to the Melinau Gorge Camp.

9.5.1.7 Trail G. From the Melinau Gorge Camp up the Melinau river, and the north-west ridge to North-east Camp and on the summit of G. Mulu. This trail passes a number of open areas from which good views may be obtained.

9.5.1.8 Demarcation of the trails is discussed in paras 12.4.5. Colour codes suggested are as follows : Trail A - red, Trail B - red and blue, Trail C - red and yellow, Trail D - yellow and blue, Trail E - yellow, Trail F - Orange, Trail G - blue.

9.5.2 The shelters (camps) on these trails are described above (9.4.4.)

9.6. Picnic sites

9.6.1 Until such time as a road into the Park is constructed picnic sites for the casual or day visitors are generally not required. Both the Deer Cave and the Paku Camps are close enough to Long Pala to be a feasible venue for a day trek. Notices must make it clear that the fragile and interesting vegetation on the limestone screes and in the amphitheatre at the mouth of the Deer Cave must not be disturbed.

9.6.2 When the Park headquarters move to a new site on the proposed road a spur road is proposed (para. 5.4.1.) in the direction of the Melinau Gorge. This will terminate at a Visitor Centre (see para. 10.2) where picnic facilities in the form of tables and benches under shelter will be needed for day visitors.

9.6.3 At this stage the Melinau Gorge Camp should be developed as a picnic site for those who want to walk from the Centre and shelters should be expanded to accommodate benches and tables. This will necessitate the need for an effective all-weather river crossing at this point.

9.7 Natural history enjoyment

9.7.1 The competence of a leader of any natural history tour must be approved by the Director of Forests and his route and programme acceptable within the policies laid down in this Plan.

9.7.2 All tour leaders should be requested to present a report or a list of species seen in the areas visited and participants should be encouraged to write up their daily observations in the Scientific Log kept in the hostel for that purpose.

9.7.3 No collecting by such parties will be allowed unless an individual permit has been issued (para. 8.4.2.7) Visitors should be encouraged, however, to study the plants and animals of the Park (cf. 8.4.2.1) and some groups may be caught and handled for identification (e.g. frogs, toads and geckos). Searching for these animals with the use of a head-lamp at night is an excellent recreational activity when flash photography and sound tape-recordings may be made.

9.7.4 The provision of suitably placed hides where visitors can watch some form of wild life, e.g. frugiferous animals feeding should be considered in the vicinity of the Visitor Centre (c f. para 8.4.2.10 and 11).

9.7.5 The provision of nature trails is considered in para. 10.2.3.

9.8. Sport fishing

9.8.1 If suitable fish species are found within the Park, (see para. 8.4.1.6.) sport-fishing should be promoted in the lower reaches of the Melinau and Tutuh in the south and the Mentawai, Medalam and Tarikan in the north.

9.8.2 A game-book should be kept in the visitors' hostel at the Southern Range Quarters and eventually at the permanent headquarters in which to register date of catch, name of angler, identity, weight and length of fish. Such a register will serve firstly to increase visitor's interest but also to monitor the effect of angling on fish stocks (see para. 8.4.1.8.)

9.9 Supporting literature

9.9.1 The National Parks Section should prepare the following for issuing or selling to visitors to the Park :

9.9.1.1 Maps of the Park showing the position of trails and the average length of time required to walk between camps.

9.9.1.2 Trail guides describing in laymen's terms the features of the rain forest through which the trail passes, emphasising outstanding (seasonal) features species of animals likely to be encountered and interesting plants known to occur along the trail. Such guides should be illustrated with thumb-nail sketches and line-drawings.

9.10 Caves

9.10.1 In both length and size of passage the caves of the limestone massif are of world importance and are considered as a prime resource for future speleological studies. For this reason future development of the tourist potential of the caves must be based on sound scientific principles.

9.10.2 Guides will require specialised training. Any fixed aids, e.g. ropes, ladders, must be made of durable materials and must be tested every three months. Guides must be instructed to prevent vandalism including name writing (para. 8.3.3.2.2 and Appendix XIX).

9.10.3 A stock of basic equipment will be required and it will be the responsibility of the Warden to see that it is kept in order. Locally available acetylene headlamps are acceptable underground lights though they may not stand up well to visitor use. More robust acetylene lamps may be imported. Spent carbide from such lamps presents a major conservation threat to natural life of the caves and arrangements must be made for it to be brought back to the Rangers' Post. Helmets should be provided for visitor use.

9.10.4 The following caves are suggested for initial development for tourist use: Gua Payau (Deer Cave); Lubang Hijau (Green Cave); and Gua Air Jernih (Clearwater Cave).

9.10.4.1 Gua Payau. This can be planned as a day's visit from Long Pala and the high level of visitation will demand a fixed interpretive display. The cave allows a route through to the blind valley between it and Lubang Hijau, and a different route back visiting a variety of points of interest on the way. The Park Rangers and labourers can set up the small amount of fixed ropes required at very little cost. Local guides will require a minimal amount of specialised training to be able to take parties through this cave. A walkway should be roped off at the entrance to ensure that all visitors follow a narrow route, animal tracks should be avoided and any deer tracks carefully preserved. An overnight shelter should be built in the main mouth (see para. 9.4.4.8).

9.10.4.2 Lubang Hijau. Development of the full potential of this cave will require the help of professional speleologists as further investigation will be necessary to determine whether a route through to the cliff overlooking the Melinau is feasible for parties. Considerable damage could be done to the unique cave features and associated plant and animal life at the cave-mouth unless strict, and well engineered, paths are adhered to.

9.10.4.3 Gua Air Jernih. This cave is relatively accessible by longboat from Long Pala for most of the year. Consideration should be given to establishing boat tours of the main river passage inside the cave and accessible from the S. Melinau. These would be a unique attraction and should eliminate danger to walking visitors due to rising water. Flooding is not regarded a hazard to visitors from the data so far available but monitoring should continue of fluctuation of levels and speed of flow of this river. There is potential for adventurous routing in this cave but local cave guides will need to gain considerable experience before this is contemplated.

9.10.5 On the completion of the Highway, caves in the northern half of the Park should be investigated with a view to developing their use for visitors. Gua Sungei Tarikan and Lubang Rendah Harimau are two systems so far known to contain this potential.

9.10.6 The demand for visitor participation of the caves will depend largely on publicity they receive. "Caves of Mulu" (Brook and Waltham,

1978) has done much to publicise the caves as have reports to international journals by the speleological team. Further publications should be prepared, in Malay and other languages, but emphasis must always be given to the need for thoroughly professional discipline by visitors to caves and the absolute prohibition of collecting mineral, plant or animal specimens and of writing names or otherwise defacing rock surfaces.

9.10.7 It should be stressed in the strongest possible terms that if archaeological items are found in caves, no unauthorised person is permitted to touch any human remains or associated artifacts, nor to disturb cave soils containing archaeological material.

10 INTERPRETATION AND EDUCATION

10.1 Policy

10.1.1 Gunung Mulu National Park will attract visitors on the merit of its spectacular landscape, its magnificent vegetation and rich diversity of animal life. Visitors will mostly be adults although when the proposed road is built, day trippers from Limbang will include family groups. The potential for educating such visitors (in many respects a captive audience) should not be lost and the National Parks Section should allocate staff and funds to develop the interpretive aspect of the Park.

10.2 Visitor/Interpretive Centre

10.2.1 An interpretive display should be constructed at the day visitors Centre on the spur road-head near the Melinau Gorge. This picnic site will be the objective of many groups that arrive by private car or group transport (bus). The details of the design are not laid down at this stage except to suggest that it should be open plan, under cover, and should at least involve a panoramic sketch of the view.

10.2.2 Design should take into account vistas opened up by the site and explain to the visitor what he is seeing in terms of simple geology geomorphology, soil type and vegetation. A full design brief should be prepared by the VSO/CUSO member of staff proposed to assist the Warden (para. 13.1.3). It should include displays on the aims of the Park, on its conservation and its role in understanding the complex ecosystem of the tropical rain forest.

10.2.3 The exhibition should encourage the visitor to see more of the intriguing environment that is around him and a number of self-guided nature trails should be open to him.

10.2.3.1 Nature Trail (a): into the kerangas. Within a short distance such aspects as lack of soil nutrition and complexity of life form compensating for this (ant-plants, pitcher plants) and the structure of the forest (its life forms and their morphology) can be demonstrated.

10.2.3.2 Nature Trail (b): into the alluvial forest. Biological phenomena such as buttress roots, epiphytism and plant parasites may be pointed out. The trail could end at the river and the Melinau Gorge Camp.

10.2.3.3 Nature Trail (c): into the limestone scree and cliff and wet gorge showing the range of life-forms of both plants and animals.

10.2.4 The proposal (para. 8.4.2.10) to develop hides in this area near (if necessary, planted) fruit-bearing trees to watch frugivorous birds and mammals would add to the interpretive facilities.

10.3 Gua Payau (Deer Cave) display

An interpretive display should be set up in the mouth of the Deer Cave describing aspects of the geomorphology that visitors taking the cave trail (see para. 9.10.4.1) will see and outlining some of the interesting biological features of caves generally.

10.4 Literature

10.4.1 This should be another project for the overseas volunteer: to prepare a series of leaflets describing the more common species or groups to be seen in the Park, e.g., snails, millepedes/centipedes, butterflies, ants/termites (and their termitaria), amphibians, conspicuous birds such as hornbills, and the smaller and medium-sized diurnal mammals, e.g., the primates and squirrels.

10.4.2 Botanical leaflets introducing pitcher plants, myrmecophilous (ant) plants, saprophytes, the leaf-shapes of nearby distinctive trees, ferns and mosses/liverworts should also be produced.

10.4.3 Each series should be designed as a project to maintain uniformity and standard. Visitors are more likely to buy a second or third leaflet if they find presentation and standards equal. Colour-printing is not essential, but copious black and white photographs will be needed. Data sufficient for many leaflets are already available from the R G S/ Sarawak Government expedition.

10.4.4 All publications should be identified by the Park logo (Fig.6)

10.4.5 Postcards from colour photographs of plants and animals and of vegetation formations and views taken in the Park should be produced for sale at points where visitors will be accommodated. They should also be offered at suitable discount prices to retail stores in Miri, Marudi and Limbang. Many suitable photographs are already available.

10.4.6 Literature explaining aspects of the evolution, geomorphology and biology of the caves must be developed in conjunction with a development programme for the caves (see para. 9.10).

11 RESEARCH

11.1 Research value of the Park

11.1.1 As stated before, Gunung Mulu N.P. contains all the major rain forest formations to be found inland in Sarawak (see para. 2.6). Its potential as a site for research into all aspects of this quickly diminishing environment is acknowledged in this plan. Information gained in the Park will have application for rain forest management, tropical silviculture and environment conservation not only in Sarawak but in S.E. Asia generally. It is the base line with which to compare the processes taking place in secondary forest.

11.1.2 The vascular plant flora (see para. 2.7) is likely to contain over 2500 species many of which may become useful to man's ever-changing needs. Wild fruit-tree species abound (e.g. Garcinia: c.30 spp; Eugenia: c.50 spp) and contain genes for not only possible desirable morphological characters but also for essential ecological qualities that will be valuable if marginal and relatively infertile land is to be utilized in the future. Similarly the Park will contain its share of species that contain useful pharmaceutical products.

11.1.3 Surveys that increase our knowledge of the plants living in the Park should be encouraged, but careful monitoring on the usefulness and value of certain species must also be undertaken and is essential if they are to be conserved. One such example is the incense wood, gaharu, which is now exploited in considerable quantities as consumer demand and prices rise rapidly. This product is the result of a fungus infection of the wood of Aquilaria microcarpa which is likely to become extinct in the Park if the value continues to rise or is even maintained. Every effort should be made

to protect this species and research into possible ways of innoculating the fungus into trees specially grown for the purpose or the synthetic production of the chemical concerned should be encouraged. It should be emphasised again that Park staff must not collect this wood (c f. para. 8.5.3.2 and 3).

11.1.4 The Park contains a number of terrestrial vertebrates (see Appendices V-VIII) endemic to Borneo or whose range is becoming restricted due to deforestation. If these species are to be conserved an understanding of their ecology, behaviour and breeding biology is essential and could be investigated in the Park. (see Appendix XVIII).

11.1.5 The potential value of aquatic animals, especially fish, to the Sarawak economy has been emphasized (cf. para. 8.4.1) It is important that at an early opportunity effort is made to acquire a fuller knowledge of the fish fauna of the Park's rivers and to investigate their biology in detail. In the meantime it is essential that the most careful protection is maintained.

11.1.6 The invertebrate fauna is vast (cf. para. 2.9) and provides limitless scope for scientific research. Management proposals envisage participation by specialists at all possible opportunities but do not envisage direct sponsorship by Park authorities.

11.2 History of exploration and collections made in the Park

11.2.1 The first published visit to the Park was by Spenser St John with Hugh Low in 1861 (St John 1862). The area of the Park was visited c. 1893 by Charles Hose, Officer-in-charge and Resident of the Baram District, 1888-1907, who collected vertebrates, plants and anthropological material.

Gunung Mulu was first reached by Edward Shackleton in 1932 with a party of guides from Long Terawan and some general observations were made (Shackleton, in Harrison, 1933). In 1935 E. Banks, the Curator of the Sarawak Museum, collected and observed mammals and birds on Gunung Mulu (Banks 1935). In 1951 a second Sarawak Museum expedition led by the then Curator, Tom Harrisson, obtained bird and mammal specimens.

11.2.2 The Forest Department initiated botanical collecting expeditions in 1961 when the real potential of the area as a National Park was realised. Specimens are housed in the Forest Herbarium, Kuching, and at the collectors' own institutes as indicated below.

Expeditions that have visited the Park are:

1961	Forest Department (J.A.R. Anderson) with H. Keng (University of Singapore)
1962	B.L. Burtt and P.J. Woods (Royal Botanic Garden, Edinburgh).
1964	M. Hotta (Kyoto University).
1966	Forest Department (J.A.R. Anderson) and W.L. Chew (Botanic Garden, Singapore).
1971	Forest Department (J.A.R. Anderson and P.P.K. Chai).
1975	B.L. Burtt (R.B.G., Edinburgh) and P.P.K. Chai.
1976	Forest Department (P.J. Martin) and A.C. Jermy (British Museum (Natural History)).

11.3 The Royal Geographical Society/Sarawak Government Expedition 1977-78

11.3.1 This major survey, was organised jointly with the Forest Department, and other Sarawak Government Departments (Agriculture, Drainage and Irrigation, and Sarawak Museum). Over the period of fifteen months from June 1977 to September 1978, 115 scientists participated in what amounted to ten thousand man/days of scientific survey and recording.

11.3.2 A general report on the work of the expedition is given in the Geographical Journal Vol. 145 pt. 2 (Hanbury-Tenison and Jermy 1979). 51 projects were carried out and are listed in Appendix XX. They fall into five groups comprising:

11.3.2.1 Geomorphological studies mainly on the limestone karst but with projects on landscape on G. Mulu (landform 1) and studies on the Quaternary terraces in landform 2.

11.3.2.2 Speleological studies by a team of six experienced cavers when over 50 km of cave passage was surveyed and the general topography recorded. Some details have been published in Caves of Mulu (Brook and Waltham 1978), and elsewhere (see Chapter 15).

11.3.2.3 Vegetation and floristic survey in which 21 botanists took part. Map 5 is one result of this project based mainly on surveys conducted by the Forest Department and, using aerial photographs taken in 1975 by the R.A.F. for the Lands and Survey Department, plotted onto 1:50,000 topographical map (DOS 434(Series T 735):sheets 3/114/4;4/114/16; 4/114/12). Appendices III and IV list preliminary results in Angiosperms, Gymnosperms and Pteridophyta; collections of Bryophyta, Fungi and Lichens are being identified by experts.

11.3.2.4 A faunistic survey into the major groups was carried out with considerable ecological emphasis on birds, amphibia and a number of invertebrate groups in particular butterflies and moths, beetles, termites, millepedes and centipedes. Systematic pit-fall trapping was carried out in all major forest formations except high level limestone. Two groups, i.e. snakes and molluscs were not studied by specialists and need to be given priority in future work. Amongst the arthropods, studies are required on mites (Acarinae), Collembola and Diptera in particular. Appendices V - X contain selected lists.

11.3.2.5 A forest ecology programme (Appendix XX: B2) was carried out with a full-time director on site throughout the whole period of 15 months. Studies here compared the nutrient balance and litter and vegetation breakdown of four forest formations: mixed dipterocarp lowland, limestone lowland, alluvial and kerangas forests. These studies involved an investigation of the soil fauna and fungal flora that played an important part in litter breakdown.

11.4 Future priorities. From the above projects a considerable base-line of data on these forest ecosystems has emerged. The Park has thus the potential for future work and priority should be given to those aspects outlined in this Management Plan and summarised as follows:

11.4.1 The effect of Penan hunter/gatherer on the *Eugeissona utilis* and larger mammals (paras 8.5.4.3 : 8.4.2.8 and Appendix XVIII).

11.4.2 Study of the populations of both animals and plants that are restricted to the more fragile habitats such as ridges, pinnacles zone and mountain tops (para. 8.3.2).

11.4.3 The caves have great research potential and specialists from throughout the world will want to visit them. Both the bonafidelity of the cavers themselves and the need for their research projects should be strictly monitored preferably by a group of locally based (Sarawak) speleologists. Initially expertise and advice can be gained from those who have already surveyed the caves on the R.G.S./Sarawak Government Expedition.

11.4.4 A continuation of the forest ecology programme (11.3.2.5) in conjunction with Sarawak scientists as a positive contribution to land use and silviculture in Sarawak.

12 DEVELOPMENT

12.1 General

12.1.1 The development of the Park during the period of this plan must take into account the changes that are likely to take place as a result of the construction of the road through the Park. Mention of these has been made in Chap.5 and some prescriptions directly concerned with the effects of the road construction are included in Chap. 14. During the period of the plan, Park headquarters will be at a temporary location at Long Pala, before being moved to a permanent site on or near the road. Buildings that are not scheduled to remain permanently at the temporary site - which will continue to be the headquarters of the Southern Range - should be easy to dismantle and erect elsewhere. It is recommended that prefabricated buildings, using chemically treated timbers, such as are manufactured in Miri, are utilized. Similarly, major developments on trails, bridges, shelters, etc., have not been proposed where these are likely to be little used when the centre for tourist development is located at the Melinau Gorge.

12.1.2 The development of facilities, buildings, etc. will require a limited amount of constructional work. Normally this would be undertaken by the Jabatan Kerja Raya (Public Works Department), but due to the present relative inaccessibility of the Park and the specialized nature of the buildings, it is recommended that the Forest Department be granted authority to utilize approved funds to plan and erect all buildings and develop facilities on its own initiative. This arrangement was formerly successfully implemented at Bako National Park.

12.1.3 The number of visitors and tourists entering the Park is likely

to be limited until there is road access. During the initial period of this plan only the basic facilities are provided. It is important, however, that such facilities are maintained in good order, and clean.

12.2 Buildings

12.2.1 Park headquarters. The temporary Park headquarters will initially be sited on the Government land at Long Pala. This site is outside the boundaries of the Park. The following buildings will be required :

(i) Park Warden's accommodation. To be converted from the existing resthouse, and to include a small office.

(ii) One prefabricated building, of suitable type, to accommodate two Park Rangers and one boathand and families.

(iii) One prefabricated building, of barrack type, to accommodate two permanent labourers, with additional rooms for the accommodation of extra temporary labourers porters and guides.

(iv) One building of a temporary nature, to accommodate the appointed volunteer.

(v) A hostel to accommodate twelve visitors (see 12.2.7).

All new constructions must be raised above highest expected flood levels.

12.2.2 The siting of these buildings requires careful consideration. The hostel should be separated from the other buildings, but in sight of them. It should be located further upstream so that all boats arriving from downstream will initially call at the Warden's office or the Rangers' quarters.

12.2.3 The natural vegetation, particularly the location of larger trees, should be taken into consideration when siting the buildings, which should be designed to blend in with the environment. Extensive areas, other than the helicopter pad, should not be opened up, though small areas can be allocated for growing fruit and vegetables. Exotic trees, shrubs and herbs should not be planted, but the whole complex, with a well-maintained path system, should have an attractive natural appearance. The painting of all buildings should be in uniform attractive colours which blend in with the surroundings.

12.2.4 The whole complex should be supplied with electricity from a generator, which must be situated out of earshot of the hostel.

12.2.5 A permanent incinerator, out of sight of all buildings, for the disposal of all rubbish, other than items of metal, should be installed. Metal items, such as tins, should be crushed and then buried in deep pits.

12.2.6 Rain water catchments systems should be installed in all buildings for the supply of drinking water. The water in the storage tanks, especially in the hostel, must be inspected frequently to ensure it does not become polluted or contaminated.

12.2.7 Hostel

12.2.7.1 The hostel to accommodate twelve persons should be sited facing the river, but far enough from the river bank to avoid insect problems (para. 8.4.2.3). It is recommended that it is of a 'longhouse' design (or of modular units) and it is considered the following are required:

(i) Three bedroom units, each containing two sets of double bunks, fully screened to exclude mosquitos (para. 8.4.2.3)

(ii) A covered verandah or walkway linking bedroom units and leading to other facilities.

(iii) A central dining area, also suitable for communal sitting room.

(iv) Duplicated kitchen facilities.

(v) Separate bathroom and toilet facilities for men and women.

(vi) A high level water tank (2000 gall.) for washing purposes, to be supplied with filtered water from the Melinau river by means of a small petrol pump (with a hand-operated pump for standby.)

12.2.7.2 Items of furniture and equipment to be installed to include:

(i) Double bunk beds, which should include a locker in design.

(ii) One mattress (in hard-wearing covers) and one foam-rubber pillow per bunk.

(iii) Sheets (10 prs) and pillow-cases (10) for hire to visitors who do not bring their own. Under no circumstances should they be permitted to sleep without linen.

(iv) Cutlery and unbreakable crockery.

(v) Adequate pans, kitchen cleaning equipment.

(vi) Butane stoves (or kerosene, oil-fuelled cooking stoves).

(vii) Large rectangular tables and benches for the dining area.

(viii) Plastic buckets and basins.

12.2.8 The staff quarters should be provided with furniture and equipment in accordance with the normal Government schedule for the grade of officer occupying the quarters.

12.2.9 The transport of building and other materials to Long Pala by river will cause problems. The use of prefabricated buildings should reduce the overall weight and bulk, and consequently the transport costs. The possible use of helicopters is strongly recommended and the possibility of the Royal Malaysian Air Force helping should be closely investigated.

12.2.10 Northern Range

12.2.10.1 Two buildings will be required at Nanga Mentawai. Here again prefabricated buildings are recommended as they may require to be moved in due course to a site on the roadside. The buildings should be similar in design to those recommended for the Rangers and labourers at Park headquarters and will accommodate: (i) two Park Rangers and their families (ii) two labourers, with an additional room for extra labourers.

12.2.10.2 Visitor accommodation in longhouse style should be built at the earliest opportunity to accommodate those (albeit few) visitors that approach the Park from Limbang.

12.3 Camps

12.3.1 The R.G.S./Sarawak Government expedition arranged for the construction of camps on Gunung Mulu and a third in the Melinau Gorge (see Map 8). These are generally satisfactory for the use of future visitors but will require improvement and, most important, frequent maintenance. Specific points regarding these shelters are as follows :

12.3.1.1 The shelters were constructed of untreated timber. Frequent repairs, and eventual reconstruction, will be required. Heavy hardwoods (belian, selangan batu, or resak) should be used for timbers in contact with the ground or exposed to the elements; chemically impregnated timbers should be used elsewhere.

12.3.1.2 The sheeting on the roofs requires to be caulked to prevent leakage which is liable to occur in driving rain.

12.3.1.3 Water supply to the camps at higher altitudes on Gunung Mulu, will always cause problems. Forty-gallon drums to catch water from the roofs of the shelters should be used, but frequent (monthly) inspections should be made to ensure that the water is clean and usable.

12.3.1.4 Well-constructed pit latrines, using timbers brought in for the purpose, must be constructed at all camps.

12.3.1.5 To maintain the pleasant and attractive environment of the camp, and conserve the vegetation, it is important that there should be no felling of trees in the immediate vicinity, either for repairs to the shelters or for firewood.

12.3.1.6 Camps should be provided with a minimum of equipment, including kettles, pans, hurricane lamps, and most important kerosene stoves. Frequent inspection, and replacement where necessary, will be required.

12.3.1.7 Kerosene must be carried in by visiting parties (suitable small-sized plastic containers to be available) for use in all camps.

12.3.1.8 Cleanliness of the camps, and in the environs thereof, is, absolutely essential. Inflammable material should be burnt, but all other non-inflammable material, especially tins, must be carried out by visitors for disposal at Park headquarters. The soils on Gunung Mulu are generally very shallow (skeletal) particularly on the ridges, and it is quite impracticable to bury rubbish.

12.3.2 These camps will be known by the following names: Paku Camp: situated by a major tributary of the Melinau Paku river; Summit Camp: the high altitude shelter on the summit ridge of Gunung Mulu; Melinau Gorge Camp: Camp 5 at the Melinau Gorge during the recent expedition.

12.3.3 Three additional camps are proposed during this plan. The prescriptions in 12.3.1.4 to 12.3.1.8 will apply also to these camps.

12.3.3.1 Kapur Camp. This camp should be constructed at the site of Camp 2, (altitude 500 m; 1660 ft) of the recent expedition. The design of the camp should be similar to that at the Summit Camp. All material for its construction should be brought in from outside the Park. Arrangements should be made to fly the material into the helicopter pad at the Paku Camp then have it carried up to the site. The water supply for this camp can be obtained from a nearby stream.

12.3.3.2 Hidden Valley Camp. This camp, situated at the Hulu Air Jernih may be constructed, under close supervision, with local materials. It should be smaller in size than the previously mentioned shelters and the roofing material should preferably be a strong polythene sheet, or kajang. If the latter is used it will require to be replaced annually. The Sungei Air Jernih will provide drinking water but care should be taken to prevent any pollution of this stream.

12.3.3.3 North-east Camp. This will be located on Trail G (see para. 12.4.2.2) on the north-east ridge of Gunung Mulu at an altitude of approximately 1500 m (5000 ft), on one of the small streams at the headwaters of the Melinau river which will be adequate for drinking purposes. As for the Hidden Valley Camp it may be constructed initially of local materials, although if this trail becomes popular a more substantial building may be needed. This would only be practical if a helicopter pad was cleared on the nearby sparsely vegetated ridge.

12.3.3.4 Pinnacles Camp. This is located at 1200 m (4000 ft) on the northern side of G. Api and, initially at least, it can be constructed under supervision from local materials taken from lower down the mountain. This should be regarded as a day shelter only and will need equipment for boiling water and a water catchment area and storage tank.

12.3.3.5 Deer Cave Camp. This is located at the mouth of Gua Payau (see 9.4.4.8.) All construction material should be brought in and the siting is critical so as to conserve the vegetation at that point.

12.4 Trails

12.4.1 The trails that have already been constructed in the Park have been discussed in para. 9.5 (and see Map 8). They are considered adequate (with two additional trails) for the period of the plan, though they may be extended when the Visitor Centre is located at the Melinau Gorge. The following trails are already in use :

Trail A From Park headquarters to the headwaters of the Melinau Paku river thence to the summit of Gunung Mulu. (Markers: red).

Trail B Branching off Trail A to the Deer Cave (Markers: red/blue).

Trail C From Park Headquarters following the Melinau river upstream to the Melinau Gorge (Markers: yellow/red).

Trail D From the Melinau Gorge to the pinnacles on Gunung Api. (Markers: yellow/blue).

Trail E From the Melinau Gorge to the Tarikan river at Lubang Cina (Markers: yellow).

12.4.2 Two additional trails (F & G) both pioneered and used during the recent expedition are prescribed during this plan.

12.4.2.1 Trail F. This branches off Trail A after the Melinau Paku river is crossed and then proceeds to the Hidden Valley Camp; it continues onto the north ridge of Gunung Mulu and along the eastern flank of G. Api to the Melinau Gorge. This trail thus provides access to the Hulu Air Jernih and enables visitors, if they wish, to make a circular trip from Park headquarters by Trail C to the Melinau Gorge, returning by Trail F; or vice versa. (Markers: orange).

12.4.2.2 Trail G. Branching off Trail F at the southern entrance to the Melinau Gorge and proceeding up the north-east ridge of Gunung Mulu to the summit. This trail will be of importance when the visitors' centre is situated near the Melinau Gorge as it will provide a path up the mountain from the Gorge. It also will provide the opportunity for visitors to make a long circular traverse over the summit of Gunung Mulu. (Markers: blue).

12.4.3 Bridges on trails. There are few hazards on the trails except when crossing the rivers. When these are in spate they can be dangerous. The Park Authorities (and the Sarawak Government) have a moral, if not legal responsibility, to protect visitors to the Park.

12.4.3.1 All rivers and streams cannot be bridged but it will be essential to have adequate bridges at the following points:

(i) On Trail A crossing the river immediately downstream of the Paku Camp.

(ii) On Trail C crossing the Melinau river downstream from the Melinau Gorge.

(iii) On Trail E crossing the Melinau river at the Gorge.

12.4.3.2 Less dangerous points where the rivers can be forded with difficulty and where bridges may be required include:

(i) On Trail A crossing the Melinau Paku river upstream of Long Melinau Paku.

(ii) On Trail G, crossing the Melinau river upstream from the Gorge.

12.4.4 Trails must be maintained and those used more frequently, such as to the summit of Gunung Mulu should be inspected monthly. At lower altitudes this will involve the maintenance of bridges. In montane forest ladders will need to be installed on the steeper parts where the vegetation is liable to be destroyed and the soil eroded as a result of frequent usage. It may also be necessary to construct small platforms over boggy parts of the trails especially in the alluvial forest.

12.4.5 Clear demarcation of trails is essential. Paint marks on trees using different colours, or different combinations of colours, for the various trails as indicated in paras 12.4.1 and 12.4.2 is generally satisfactory at low altitude though it is necessary to inspect the demarcation at six-monthly intervals and repaint as necessary. At higher altitudes paint on the heavily moss encrusted trees is unsatisfactory and the use of coloured discs, plastic or aluminium, is recommended. These should be nailed to trees with galvanised nails and allowance must be made for the future growth of trees. It is recommended that in due course paths at lower altitudes should be similarly demarcated. Junction points on trails, and at other localities where visitors are liable to be confused, should be clearly sign-posted.

12.5 Transport

12.5.1 The following transport will be required and will be based in the Park.

Southern Range:	One large longboat with 18/20 H.P. engine (to be driven by the Boathand/Driver) One small longboat with 10 H.P. engine, mainly for use of the rangers.
Northern Range:	One small longboat with 10 H.P. engine for use of the rangers.

12.5.2 It is recommended that the Park should not provide transport solely for bringing visitors to and from the Park; arrangements should be made, and fees agreed, with reputable persons in Marudi, Limbang and Long Terawan for this purpose. Visitors may however use National Parks' transport, at the standard rate, if this is available and is proceeding to or from the Park on normal duties.

12.5.3 Whilst in the Park visitors may be permitted to hire transport, together with driver, at rates to be decided, to proceed up the Melinau river to the confluence with the Lutut river or to go up the Tutuh river to the base of the rapids.

12.6 Helicopter pads

12.6.1 During the recent expedition four helicopter pads were constructed at the following locations (see Map 7):

(i)	At Long Pala near the Basecamp
(ii)	Near the Paku Camp at the base of the mountain, on the banks of a tributary of the Melinau Paku river.
(iii)	On the summit ridge, near the Summit Camp
(iv)	Melinau Gorge, adjacent to the Camp.

12.6.2 These helicopter pads should be maintained by occasional clearance of the regrowth. Care should also be taken to ensure that trees on the approaches to the pads do not grow too tall.

12.6.3 No new helicopter pads are prescribed. If materials for the construction of the buildings in the northern range at Nanga Mentawai are to be moved in by helicopter a pad will need to be constructed. This should be situated preferably outside the boundaries of the Park, possibly on a sandbank in the riverbed.

12.7 Communications

12.7.1 Radio communications will be essential both between Southern Range Post and the Northern Range Post, and to contact Marudi. Four simple and reliable radio transmitters, adequate for the range in mountainous and rain forest conditions, should be obtained and located :

Southern Range Post: One, plus one spare

Northern Range Post: One

Marudi: One

12.7.2 The Park headquarters, wherever it may be located should possess a radio of sufficient calibre to contact Miri Control Centre and thereby be linked to the land-line or radio-phone extending throughout Sarawak. Thus the Warden can speak to the Miri office or if necessary to Kuching.

12.7.3 The batteries should be rechargeable by the electric generator at Southern Range Post and a small generator at the Northern Range Post.

13 ADMINISTRATION

13.1 Staff organisation

13.1.1 The staff required for the administration of the Park will comprise :

1 Park Warden (Senior F.O. grade) stationed initially at the Southern Range Quarters and then at Park Headquarters.

1 Deputy Park Warden (F.O. grade) stationed with the Warden.

2 Senior Park Rangers (A.F.O. grade), one stationed at Long Pala to cover the Southern Range and the other at Nanga Mentawai for the Northern Range.

10 Park Rangers (Forest Guard Grade) divided equally between the two ranges or as needed.

4 Boathand/drivers (Boathand grade) to be stationed at the Southern Range Quarters.

6 Labourers to be stationed as needed.

13.1.2 When considering the recruitment of these officers, local qualifications, and, in respect of the Park Rangers, jungle knowledge, are of paramount importance. Educational qualifications are of secondary importance, though Rangers should be literate. The Rangers for the Southern Range should be recruited from the Tutuh peoples, whilst those to be stationed in the Northern Range should be selected from the inhabitants of the longhouses in the Medalam.

13.1.3 It is recommended that approval should be sought for the employment of one overseas volunteer (V.S.O., C.U.S.O., etc) for the duration of this plan. If the approval of the Sarawak and Malaysian governments is obtained it is further recommended that the I.U.C.N. should be approached to select the candidate and partially or wholly fund his employment. His basic duties would be to assist the Warden in the implementation of the plan with particular regard to conservation measures and are elaborated in Appendix XXI.

13.1.4 A permanent force of six locally recruited labourers will be required. This force should be divided between the two ranges. Their duties will be primarily to accompany Rangers on patrol duty (a Ranger will not be prepared to undertake extensive patrols alone). Whilst in the range posts they will of course be employed on other duties, but they should not be used as porters for visitors.

13.2 Administrative responsibility

13.2.1 The Head of the National Parks and Wildlife Section in the Forest Department, stationed at Kuching, is responsible directly to the Director of Forests. He is responsible for management and development of the Park as laid down in this Plan. The Section Forest Officer for the Fourth and Fifth Divisions stationed at Miri shall be responsible for the day-to-day administration of the N.P. and W.S. staff within his area. The chain of responsibility within the Park sphere of operations would then be :

1. National Parks Officer, responsible for Fourth and Fifth divisions, stationed at Miri (Executive Forester grade)
2. Park Warden Gunung Mulu National Park (or Deputy) stationed at Park headquarters (Senior Forest Officer / F.O.grades).
3. Senior Park Rangers, Gunung Mulu National Park, stationed within the Park (A.F.O. grade)
4. Park Rangers, Gunung Mulu National Park, stationed within the Park (F.G. grade)

13.3 Staff duties

13.3.1 The Warden will be responsible for all activities within the Park in the implementation of this plan; for supervising and directing the Park Rangers with particular regard to patrolling the Park; for the maintenance of the facilities of the Park; for the administration and supervision of visitors, and for the maintenance of all Park records.

13.3.2 Senior Park Rangers will be responsible for allocating the work schedule to the Park Rangers. They will be responsible to the Warden and will be also required to assist with the administration and supervision of visitors.

13.3.3 Park Rangers will be mainly engaged in patrolling, and whilst in range posts they will check on persons, either on foot or in boats, passing the posts. They will be responsible to the Senior Park Ranger within their unit who may require them to undertake other Park duties, such as inspection of, and repairs to, trails, when not engaged on patrol duties.

13.4 Staff Training

13.4.1 Warden No specific course of training can be recommended, but the Head, National Parks Section, should ensure that the Warden obtains adequate in-service training, and should investigate and recommend the possibility of sending him on some appropriate course of training in S.E. Asia or elsewhere, for example the Nature Conservation and Wildlife Management training school at Ciawi, Indonesia.

13.4.2 Park Rangers It is assumed that the recruited officers will be sufficiently familiar with working in the primary rain forest, but they should receive instruction on the following points :

(i) Use of prismatic compass

(ii) Relevant parts of the National Parks and Wildlife Ordinances

(iii) All protected animals

(iv) Park rules as applied to visitors

(v) Procedures for patrolling and for the investigation of illegal acts

(vi) Maintenance of trails, boundaries and camps

(vii) Hygiene and simple first aid

(viii) Maintenance of outboard engines (it is assumed that they will be capable outboard drivers)

(ix) Use and simple maintenance of transmitter radios

(x) Upkeep of records

14 PRESCRIPTIONS CONCERNING THE PROPOSED ROAD THROUGH THE PARK

14.1 General

14.1.1 As mentioned previously (chap. 5) the proposed road through the Park will provide relatively easy access which will alter fundamentally the future management of the Park. Though the construction of the road will not be completed during the period of this plan (it is possible that major road-building equipment will not have even reached the boundaries of the Park) some initial protective measures must be taken to safeguard the Park, prior to and during construction of the road. At the same time investigations should be undertaken to determine the future development of the Park when the road has been completed.

14.1.2 It is important that there should be close liaison at all levels between the Forest Department (especially the National Parks' officers) and the Jabatan Kerja Raya (Public Works Department) and their sub-contractors. Such liaison should be aimed at enlisting the support of the J.K.R. in the protection of the Park and minimising damage during the construction of the road. It is to be hoped that the interest and cooperation of the J.K.R. will continue and be such that it will ensure that the alignment of the road is to the best advantage of the Park and that during construction some thought is given to landscaping the disturbed land at the periphery of the road. Any proposal to plant trees or shrubs should make use of local species indigenous to the Park and at no time should alien species be introduced.

14.1.3 When the road alignment is surveyed and marked out the Head, National Parks Section, should check and review the alignment in the light of field knowledge and make any recommendations about minor realignments that would be to the advantage of the Park. Such realignments may be required where there is a likelihood of excessive damage to the habitat. Alignments may also be recommended to provide a more scenic route through the Park, preferably at one or more points providing open vistas of the limestone massif and Gunung Mulu.

14.2 Protection of the Park during construction of the road

14.2.1 During the demarcation of the alignment and thereafter it is absolutely essential that the site is patrolled frequently throughout its length to ensure that there are no illegal acts, in particular the felling of forest adjacent to the road trace. Immediate action must be taken on all offences committed to prevent any repetition. Such patrols should be undertaken weekly and should take precedence over the general patrolling of the Park (para. 8.8.2).

14.2.2 Large National Parks' notice plates should be erected at both entry points into the Park as soon as the preliminary road trace has been cut.

14.2.3 The buffer zone (para. [illegible].2) of 20 chains (400 m) should be maintained at the road entry points into the Park.

14.2.4 No Government officers or labourers, engaged in the construction of the road, or in any of the preliminary survey work, may be permitted to carry guns, fishing tackle etc. into the Park and no hunting or fishing by these persons is to be permitted. It is important that personnel are informed of these rules prior to parties entering the Park.

14.2.5 Before road construction work begins in the Park, including the initial felling of the forest along the road trace, temporary Park rangers posts must be established at road entry points. Timber for the construction of these can be obtained from the immediate vicinity, outside the Park boundary. In due course these buildings will be replaced by permanent Rangers' quarters (see para. 12.2.10).

14.2.6 The Warden should ensure that these posts are manned at all times at least by one Ranger assisted by one labourer.

14.2.7 The Warden, or some other officer appointed by the Head, National Parks Section, should liaise closely with the Site Manager/Engineer-in-charge during the period of the road construction in order to minimize damage to, and disturbance of, the Park. Particular points to be avoided are :

14.2.7.1 Excessive or unnecessary felling of trees. Only the trees required to be felled for the road itself and those that are liable to fall into the road should be felled and removed.

14.2.7.2 Erosion of hillsides. This could be a serious problem on the steep, dissected terrain on the Setap Shale Formation; also on the margins of terraces. Preventive measures must be taken.

14.2.7.3 Pollution of rivers, especially the Mentawai river and impoundment of small streams leading to local flooding and consequent death of forest.

14.2.7.4 Damage to fragile limestone habitat. If limestone is required for ballast, it must be obtained outside Park limits. A suitable source exists in the hill at G.R. 4430 to 31 Km E : 1348 to 49 Km N.

14.2.7.5 Severe compaction of the soil along the road margins by heavy equipment.

14.2.8. Road constructors should be requested to plant areas along sides of both main and spur roads to restore landscape and prevent erosion

14.2.9 Road construction camps should be located outside the Park boundary as the pollution and disturbance that would arise would be detrimental. Such camps are often situated at river crossings and obvious locations would be where the road crosses either the headwaters of the Lutut river or, more likely, the Mentawai river. As these locations are possible sites for the permanent Park headquarters, heavy disturbance that would result from a road construction camp in either locality must be resisted.

14.3 Future developments resulting from the new access (see Map 7)

14.3.1 During the period of this plan careful and detailed investigations will be required to determine the long-term development of the Park. The broad outlines only of these investigations are considered here. It is recognised that the permanent Park headquarters will need to be established at some point on the road.

14.3.2 Spur roads It is understood that the facilities of the road building agency (JKR) can be utilised to construct small spur roads where considered advantageous and to maximise the positive effect of the highway two such roads are proposed: one to the Melinau Gorge area at the end of which a Centre for day visitors will be located (see 14.3.3; 9.4.5 and 10.2 and Map 7). The second is a road running outside the Park to the temporary Park headquarters at Long Pala.

14.3.2.1 Spur road to the Melinau Gorge area.

Only a very preliminary alignment can be considered at present (see Map 7) until the final route of the main road has been decided.

The alignment should be decided by the National Parks Section so that there is minimal disturbance of the habitat. It is likely that the road will initially traverse the steep dissected terrain of the Setap Shale Formation thence cross a short section of the alluvial plain before ascending about 30m (100ft) onto the large terrace which lies west of the Melinau Gorge. It is recommended that the end of the road, where the Visitors' Centre should be located (see 14.3.3) should be where the terrace abuts onto the west bank of the Melinau river about 1.5 km (1 mile) downstream of the Melinau Gorge.

14.3.2.2 The specification for this road should be decided by the Head, National Parks' Section. It is recommended that it is a narrow width single track road with convenient passing places. It must however be an all-weather road and will be open at stated hours for Park visitors. It should otherwise only be used by National Parks' and other authorised Government vehicles.

14.3.2.3 Spur road to Long Pala This road which lies outside the Park boundaries throughout its length will be open to the public and will therefore be a JKR responsibility both for its construction and maintenance. It is possible that some form of agricultural development, possibly for the Penan community (para. 8.5.4.) may be implemented in this area. The road should end at or close to Long Pala. The advantages of this road will be the access and communications that it provides, especially to the paths leading to the Gua Payau and the west ridge of Gunung Mulu, and for administrative and protection purposes to the Southern Range quarters at

Long Pala itself where some visitors' accommodation and facilities will be maintained. A small car park must be constructed at an appropriate site.

14.3.3 Park headquarters and Visitor Centre

14.3.3.1 The site of the permanent Park headquarters will require to be closely investigated. This should be started as soon as the road trace has been cut and completed before actual road constructional work has begun. Ideally the site should be on the western side of the Park and outside the Park boundary. Furthermore if situated at the entrance to the Melinau Gorge spur road it could control access to that area. A site on or near the true right bank of Sungei Lutut is the obvious first choice, but there may be difficulties in finding a suitable location on the steep terrain there. Furthermore the water supply from the Lutut river may be inadequate for the long-term development of the headquarters. Should this site prove unsatisfactory the Mentawai crossing is the probable second choice. The water supply there is surely adequate and the sandy alluvial soils on either side of the river will provide enough space for the development of the headquarters. The flood level of the river would require to be investigated.

14.3.3.2 The proposed lay-out of the site should be decided in advance so that the assistance of the J.K.R. may be sought for any limited earth moving that may be required. It is visualised that in the initial phase the headquarters will comprise :

(i) Family accommodation for Park Warden.

(ii) Park Warden's office, with adjacent laboratory/office for visiting scientists or National Parks officers.

(iii) Family accommodation for two Park Rangers.

(iv) Accommodation for two labourers with additional rooms for extra labourers.

(v) Chalet accommodation for 8 official and V.I.P. visitors.

(vi) Hostel accommodation for 20 tourist visitors.

(vii) Central cafeteria and lounge (which may also be used by day visitors).

(viii) Car Park for twenty vehicles.

14.3.3.3 Embodied in the lay-out proposed above is an additional Rangers' quarters. If, however the site on the Mentawai (site B) is selected for the headquarters, the Rangers' quarters at Nanga Mentawai need not be developed and the rangers stationed at Park headquarters will be responsible for patrolling the road and both entrances.

14.3.3.4 Visitor Centre in the Melinau Gorge area. The site of this centre will be at the end of the spur road (see para. 14.3.2.1) and should be selected to provide panoramic views of the Gorge and mountains. The site should be developed carefully to ensure the minimum damage to the fragile habitat of the kerangas forest on the terrace and at the same time provide the most attractive surroundings for visitors.

14.3.3.5 The initial development of the Visitor Centre should include :

(i) Day centre for visitors with picnic facilities, cafeteria and toilets.

(ii) Interpretation area with office/restroom for Park staff.

(iii) Car park initially for 20 cars.

Later development should consider hostel accommodation for visitors (tourists) on this site.

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A. Place names in the Park compiled by J. Proctor and accepted by D.L.S. Kuching, 1979.

Names for river junctions (Long, Nanga) are omitted: they follow the name of the smaller river. In this Plan 'Sungai' may occasionally be rendered by the alternative 'Sungei'.

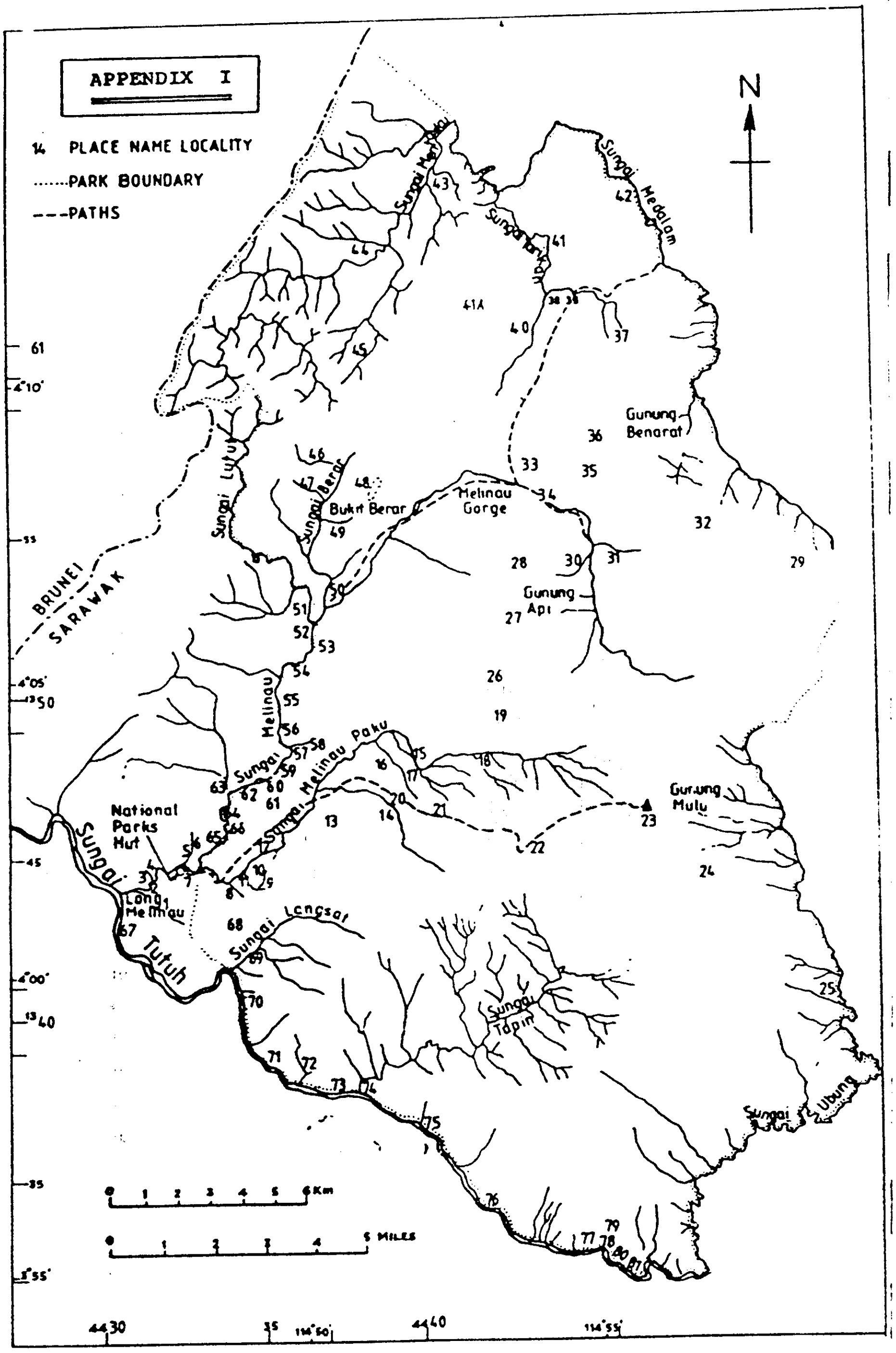
Local Name	Accepted name
1. Likoh Bulu	Sungai Bulu
2. Bitoh Tukan	Bukit Tukan
3. Likoh Bioh	Sungai Air Panas
4. Bitoh Tama Enum	Bukit Tama Enum
5. Bitoh Long Tonguloh	Bukit Long Pala
6. Likoh Tonguloh	Sungai Pala
7. Bitoh Loyang Kelaiq	Bukit Lubang Kelaiq
8. Likoh Tama Sawih	Sungai Tama Sawih
9. Loyang Payau	Gua Payau
10. Bitoh Loyang Payau	Bukit Gua Payau
11. Likoh Payau	Sungai Payau
12. Likoh Pakoh	Sungai Melinau Paku
13. Bitoh Bakatam	Bukit Bakatam
14. Bitoh Pajing	Bukit Pajing
15. Loyang Upoh	Gua Harimau
16. Likoh Diran	Sungai Diran
17. Lokoh Besale	Sungai Besale
18. Likoh Hutan	Sungai Hutan
19. Likoh Iman	Sungai Iman
20. Likoh Nipa	Sungai Nipa
21. Bitoh Goyang	Batu Goyang
22. Tecoh Tumau	Bukit Tumau
23. Tecoh Kijih or Tecoh Belinau or Tecoh Ubong	Gunung Mulu
24. Tecoh Likoh Ubong	Bukit Sungai Ubung
25. Likoh Ubong	Sungai Ubung
26. Punang Likoh Lineng Pi	Hulu Air Jernih
27. Tecoh Bitoh Apoy	Gunung Api
28. Bitoh Keleo	The Pinnacles

29.	Tecoh Tamacu	Gunung Tamacu
30.	Likoh Takion	Sungai Takiun
31.	Likoh Tabaun	Sungai Tabaun
32.	Pantu Ridge	Pantu Ridge
33.	Loyang Upoh	Lubang Upoh
34.	Melinau Gorge	Melinau Gorge
35.	Tecoh Pote	Bukit Buda
36.	Tecoh Belirang	Gunung Benarat
37.	Tecoh Mentawai	Bukit Mentawai
38.	Loyang Kina	Lubang Cina
39.	Bitoh Loyang Kina	Bukit Lubang Cina
40.	Bitoh Agung	Bukit Agung
41.	Likoh Nela	Sungai Tarikan
41a.	No local name	Bukit Tarikan
42.	Likoh Medalam	Sungai Medalam
43.	Likoh Mentawai	Sungai Mentawai
44.	Likoh Metalang	Sungai Metalang
45.	Bitoh Keleo	Batu Keleo
46.	Likoh Anau	Sungai Anau
47.	Likoh Yap	Sungai Yap
48.	Bitoh Long Tama Mut	Bukit Berar
49.	Likoh Tama Mut	Sungai Tama Mut
50.	Likoh Berar	Sungai Berar
51.	Likoh Litau Pi	Sungai Lutut
52.	Likoh Loyang Takalo	Sungai Lubang Takalo
53.	Bitoh Jia	Batu Jia
54.	Maiq Bitan-	Bitang Rapids
55.	Pulau Libu	Pulau Libu
56.	Labuko Kulabau	Lubuk Kulabau
57.	Likoh Lineng Pi	Sungai Air Jernih
58.	Loyang Lineng Pi	Gua Air Jernih
59.	Loyang Biu	Lubang Angin
60.	Loyang Bungan	Lubang Bungan
61.	Bitoh Bungan	Batu Bungan
62.	Tatang Tasum	Air Tenang Tasum
63.	Likoh Datayan	Sungai Datayan
64.	Bitoh Sila Baru	Batu Sila Baru
65.	Likoh Belinau	Sungai Melinau
66.	Likoh Lupa	Sungai Lupa

67.	Likoh Tutoh	Sungai Tutuh
68.	Tecoh Lecat	Bukit Langsat
69.	Likoh Lecat	Sungai Langsat
70.	Maiq Lisan	Lisan Rapids
71.	Maiq Bitch Mulong Dik	Batu Malan L. Rapids
72.	No local name	Sungai Aro Tuan
73.	Maiq Tuan	Tuan Rapids
74.	Likoh Tapin	Sungai Tapin
75.	Maiq Tawak	Tawak Rapids
76.	Maiq Bitoh Mulong Kijih	Temolong Rapids
77.	Maiq Maleh	Malih Rapids
78.	Maiq Gelameh	Gelamih Rapids
79.	Likoh Sepugin	Sungai Sepugin
80.	Maiq Usan	Usan Rapids
81.	Maiq Bitang	Long Tao Rapids

B. Names of caves (Map 4) as submitted to D.L.S. with English name used in Caves of Mulu (Brook & Waltham 1978)

English name	Proposed Malay name
Deer Water Cave	Lubang Sungai Payau
Mayday Dave	Lubang Darurat
Snake Cave	Lubang Ular
Green Cave	Lubang Hijau
Solo	Lubang Sendirian
Tiger Cave	Gua Harimau
Prediction Cave	Lubang Ramalan
Wonder Cave	Gua Ajaib
Tiger Foot Cave	Lubang Rendah Harimau
Tarikan River Caves	Gua Sungai Tarikan
Clearwater Cave	Gua Air Jernih
Cave of the Winds	Lubang Angin


APPENDIX I
14 PLACE NAME LOCALITY
.......PARK BOUNDARY
---PATHS
N
BRUNEI
SARAWAK
Sungai Lutut
Sungai Berar
Bukit Berar
Melinau Gorge
Gunung Benarat
Gunung Api
Sungai Medalam
Sungai Melinau
Sungai Melinau Paku
National Parks Hut
Long Melinau
Sungai Tutuh
Sungai Lansai
Sungai Tapin
Gunung Mulu
Sungai Ubung
0 1 2 3 4 5 6 Km
0 1 2 3 4 5 MILES
4°10'
4°05'
4°00'
3°55'
114°50'
114°55'

The Gunung Mulu National Park Proclamation

No. 2852

THE NATIONAL PARKS ORDINANCE

THE GUNONG MULU NATIONAL PARK PROCLAMATION

(Made under section 7(2))

1. This Proclamation may be cited as the Gunong Mulu National Park Proclamation, 1974.

2. The land described in the Schedule shall with effect from 1st August, 1974 be constituted a National Park, to be known as the Gunong Mulu National Park.

3. The privileges conceded within the National Park shall, subject to the provision of section 14 of the National Parks Ordinance, be as follows:

(a) The inhabitants of the following longhouses under the jurisdiction of Penghulu Baya Malang:

Kuala Tutoh (Long Kiput)
Batu Belah
Long Panai
Long Terawan
Long Melinau
Sungei Iman
Sungei Abang
Sungei Ubong
Sungei Tapin

shall have the privilege of hunting pig (*Sus* spp.) and deer (*Tragulus* spp., *Muntiacus* spp. and *Cervus* spp.) within the drainages of the Sungei Melinau Paku, Sungei Lansat, Sungei Tapin and other small rivers draining into the Sungei Tutoh between Long Tapin and Long Melinau.

(b) The inhabitants of the longhouses mentioned in paragraph (a) above shall have the privilege of taking fish from the Sungei Melinau Paku, Sungei Lansat, Sungei Tapin and other small rivers draining into the Sungei Tutoh between Long Tapin and Long Melinau and all tributaries of these rivers.

(c) The inhabitants of the longhouses mentioned in paragraph (a) above shall have the privilege of collecting from the areas mentioned in paragraph (a) the following forest produce:

(i) damar,

(ii) rotan,

(iii) getah, including jelutong, getah rian, and malau,

(iv) pandan leaves, and leaves of other plants, for basket making and weaving,

(v) edible plants or parts thereof, including fruits, leaves, roots.

(d) Nomadic Punans living within the Park, shall have the privileges mentioned in paragraphs (a) to (c) above but such privileges shall cover the whole area of the Park. In addition, the Nomadic Punans shall have the privilege of taking timber and poles for firewood and the construction of temporary houses. Nomadic Punans that adopt a settled mode of existence shall forego the privileges included in this paragraph and have the same privileges as the inhabitants of the longhouses mentioned in paragraph (*a*).

(*e*) The inhabitants of the longhouse at Long Seridan shall have the privileges mentioned in paragraphs (*a*) to (*c*) above but such privileges shall be confined to the drainage of the Sungei Ubong and its tributaries.

(*f*) The inhabitants of the longhouses under the jurisdiction of Penghulu Madang shall have the privileges of hunting pig (*Sus* spp.) and deer (*Tragulus* spp., *Muntiacus* spp. and *Cervus* spp.) within the drainage of the Sungei Mentawai, and of taking fish from the Sungei Mentawai and its tributaries.

SCHEDULE

(paragraph 2)

BOUNDARY DESCRIPTION

Name:	Gunong Mulu National Park
Division:	Fourth and Fifth
District:	Baram and Limbang
Area:	130,630 acres approximately

Boundaries:

Commencing at Nanga Mentawai the boundary follows the true left bank of Sungei Medalam upstream for 1,136 chains to the mouth of a tributary, 530 chains on a bearing 24° 00′ from the summit of Gunong Mulu; thence along a cut line bearing 180° 00′ for 60 chains to the Fourth/Fifth Divisional boundary; thence in a South-easterly direction along the Divisional boundary for 95 chains to a ridge; thence in a South south-westerly direction along the watershed of Sungei Seridan and Sungei Melinau for 252 chains to the source of Sungei Ubong; thence downstream along the true right bank of Sungei Ubong for 1,341 chains to its confluence with Sungei Tutoh; thence downstream along the true right bank of Sungei Tutoh for 1,027 chains to the mouth of Sungei Lansat on the true right bank; thence along a series of cut lines bearing 314° 00′ for 25 chains, 260° 30′ for 6 chains, 314° 00′ for 4 chains, 215° 30′ for 1 chain, 314° 00′ for 51 chains and 10° 00′ for 110 chains to a point on the true left bank of Sungei Melinau Paku; thence downstream along the true left bank of Sungei Melinau Paku for 7 chains to its confluence with Sungei Melinau; thence upstream along the true left bank of Sungei Melinau for 520 chains to the mouth of Sungei Putut; thence upstream along the true left bank of Sungei Putut for 505 chains to its source; thence a cut line bearing 312° 00′ for 15 chains to the Fourth/Fifth Divisional boundary; thence in a South-westerly direction along the Divisional boundary for 76 chains to the Sarawak/Brunei International boundary; thence in a north-easterly direction along the International boundary for 716 chains to a point on a straight line joining Bukit Ulu Tutong and Nanga Mentawai; thence a cut line bearing 129° 00′ for 186 chains to Nanga Mentawai, the point of commencement.

N.B. Bearings and distances are approximate only and the demarcated boundaries shall be considered correct.

IGNATIUS L. ANGKING,
Resident, Fourth Division

A preliminary list of Angiosperms and Gymnosperms recorded within Gunung Mulu National Park. Within major divisions families arranged alphabetically.

Compiled by J.A.R. Anderson and P.P.K. Chai with help from many other botanists who identified material.

Coniferophyta

ARAUCARIACEAE

Agathis borneensis Warburg

PODOCARPACEAE

Dacrydium beccarii Parl. var. beccarii
D. xanthandrum Pilger
Falcatifolium falciforme (Parl.) de Laubenfels
Phyllocladus hypophyllus Hook. f.

GNETACEAE

Gnetum cuspidatum Bl.
G. diminutum Markgraf
G. gnemon L. var. tenerum Markgraf
G. gnemonoides Brongn.
G. leptostachyum Bl. var. leptostachyum
G. macrostachyum Hook. f.
G. neglectum Bl.

Magnoliophyta: Liliopsida

ARACEAE

Agalonema simplex Bl.
Alocasia denudata Engl.
A. porphyroneura Hallier ex Engl.
A. macrorrhiza (L.) Schott
Amorphophallus species indet.
Aridarum caulescens M. Hotta
Bucephalandra motleyana Schott
Cryptocoryne longicanda Engl.
Homalonema humilis (Jack) Hook. f.
H. humilis var. ovatifolia M. Hotta
H. insignis N.E. Br.

H. sagittifolia Jungh. ex Schott
Piptospatha elongata N.E. Br.
Pothos borneensis Furtado
P. insignis Engl.
Schismatoglottis multinervia M. Hotta
Scindapsus latifolius M. Hotta

BURMANNIACEAE

Burmannia championii Thwaites
B. longifolia Becc.
B. lutescens Becc.

COMMELINACEAE

Forrestia marginata Hassk.

CYPERACEAE

Carex aff. cruciata Wahlenb.
C. dietrichiae Boeck
C. indica L.
C. perakensis C.B. Clarke var. borneensis (C.B. Clarke) Noot.
Cyperus kyllingia Endl.
Gahnia borneensis Benl
Mapania cuspidata (Miq.) Uitt.
M. monostachya Uitt.
Paramapania radians (C.B. Clarke) Uitt.
Scleria lithosperma (L.) Sw.
Thorachostachyum bancanum (Miq.) Kurz

FLAGELLARIACEAE

Hanguana malayana Merr.
Joinvillea borneensis Becc.

GRAMINEAE

Centotheca latifolia (Osb.) Trin.
C. lappacea (L.) Desv.
Cyrtococcum accrescens (Trin.) Stapf
Digitaria setigera Roth ex Roemer & Schultes
Racemobambos glabra Holtt.

HYPOXIDACEAE

Curculigo latifolia Dryand

LILIACEAE

Dianella javanica Bl.
Smilax leucophylla Bl.
S. megacarpa DC.
S. odoratissima Bl.

MARANTACEAE

Donax canniformis (Forst.) K. Schum.
Phrynium capitatum Willd.
Stachyphrynium species indet.

MUSACEAE

Musa campestris Becc.

ORCHIDACEAE

Anaechtochilus setaceus Bl.
Aphyllorchis pallida Bl.
Appendicula xytriophora Reichb. f.
Arundina graminifolia (Don) Hochr.
Bulbophyllum barrinum Ridl.
B. aff. corticola Schlechter
B. disjunctum Ames & Schweinf.
B. elatius Ridl.
B. aff. gibbosum (Bl.) Lindl.
B. membranifolium Hook. f.
B. ovalifolium (Bl.) Lindl.
B. salaccense Reichb. f.
B. aff. sopoetanense Schlechter
B. trichoglottis Ridl.
Calanthe aff. pulchra (Bl.) Lindl.
C. triplicata (Willem.) Ames
C. veratrifolia R. Br.
Ceratostylis subulata Bl.
Chelonistele lurida (L. Lind. & Cogn.) Pfitz.
C. perakensis (Rolfe) Ridl.
C. sulphurea (Reichb. f.) Pfitz.
Coelogyne craticulaelabris Carr.
C. hirtella J.J. Sm.
C. moultonii J.J. Sm.
C. pandurata Lindl.
C. swaniana Rolfe
Cymbidium dayanum Reichb. f.
C. lancifolium Hook.
Cystorchis macrophysa Schlechter
Dendrobium cinnabarinum Reichb. f.
D. linnearifolium Hook. f.
D. ovatifolium Ridl.
D. aff. tetraedre Lindl.

Dendrochilum alatum Ames
D. gibbsiae Rolfe
D. haslamii Ames
D. aff. ramosissimum (Ridl.) J.J. Sm.
Didymoplexis striata J.J. Sm.
Epigeneium labuanum (Lindl.) Summerh.
E. suberectum (Ridl.) Summerh.
Epipogium roseum (D. Don) Lindl.
Eria aff. hosei Rendle
E. longifolia Hook. f.
E. melaleuca Ridl.
E. obliqua Lindl.
E. robusta (Bl.) Lindl.
E. teretifolia Griff.
Lecanorchis multiflora J.J. Sm.
Liparis gibbosa Finet
Malaxis amplectens (J.J. Sm.) Ames & Schweinf.
M. aff. nemoralis (Ridl.) Holtt.
M. perakensis (Ridl.) Holtt.
Nephelaphyllum trapoides J.J. Sm.
Phaius tankervilleae (Banks) Bl.
Pholidota pectinata Ames
Plocoglottis acuminata Bl.
P. borneensis Ridl.
P. hirta Ridl.
Podochilus microphyllus Lindl.
P. rupicola Ridl.
Spathoglottis ?confusa J.J. Sm.
Thelasis micrantha (Brongn.) J.J. Sm.
Trichotosia ferox Bl.
T. unguiculata (J.J. Sm.) Kraenzl.
Vrydagzynea albida Bl.
Zeuxine linguella Carr.
Z. violascens (Bl.) Ridl.

PALMAE

Areca abdulrahmanii Dransf.
A. dayung Dransf.
A. minuta Scheff.
Arenga borneensis (Becc.) Dransf.
A. brevipes Becc.
A. undulatifolia Becc.
Calamus ashtonii Dransf.
C. blumei Becc.
C. aff. ciliaris Becc.
C. conirostris Becc.
C. divaricatus Becc.
C. equisitus Dransf.
C. flabelloides Furtado
C. gonospermus Becc
C. hewittianus Becc.
C. hispidulus Becc.
C. jaherianus Becc.

C. javensis Bl.
C. aff. javensis (includes 5 taxa)
C. kiahii Furtado
C. laevigatus Mart. var. laevigatus
C. laevigatus var. mucronatus (Becc.) Dransf.
C. leloi Dransf.
C. lobbianus Becc.
C. marginatus Mart.
C. muricatus Becc.
C. nematospadix Becc.
C. nielsenii Dransf.
C. ornatus Bl.
C. paspalanthus Becc.
C. pogonacanthus Becc.
C. sarawakensis Becc.
C. scipionum Lour.
C. aff. semoi Becc. (includes 2 taxa)
C. sordidus Dransf.
C. zonatus Becc.
Caryota mitis Lour.
C. no Becc.
Ceratolobus concolor Bl.
C. discolor Becc.
C. subangulatus Becc.
Daemonorops asteracantha Becc.
D. atra Dransf.
D. collarifera Becc.
D. didymophylla Becc.
D. formicaria Becc.
D. hystrix (Griff.) Mart. complex (includes 5 taxa)
D. ingens Dransf.
D. longipes (Griff.) Mart.
D. oblata Dransf.
D. oxycarpa Becc.
D. pericantha Miq.
D. pseudomirabilis Becc.
D. sparsiflora Becc.
D. spectabilis Becc.
D. species indet., sect. Cymbospatha
Eugeissona minor Becc.
E. utilis Becc.
Iguanura melinauensis Kiew
Korthalsia cheb Becc.
K. concolor Burret
K. echinametra Becc.
K. ferox Becc.
K. hispida Becc.
K. macrocarpa Becc.
K. rigida Bl.
K. scaphigera Griff. ex Mart.
K. aff. scaphigera Griff. ex Mart.
Licuala borneensis Becc.
L. lanata Dransf.
L. aff. olivifera Becc.
L. aff. orbicularis Becc.

Nenga pumila (Mart.) H. Wendl.
Oncosperma horridum Scheff.
Pholidocarpus maiadum Becc.
Pichisermollia insignis (Becc.) H. Monteiro-Neto var. moorei Dransf.
Pinanga albescens Becc. ex H. Winkler
P. aristata (Burret) Dransf.
P. brevipes Becc.
P. capitata Becc. ex Gibbs var. capitata
P. capitata var. divaricata Dransf.
P. chaiana Dransf.
P. crassipes Becc.
P. dumatosa Dransf.
P. keahii Furtado
P. lepidota Rendle
P. malaiana (Mart.) Scheff. var. baramensis Becc. ex Mart.
P. minuta Furtado
P. mirabilis Becc.
P. mooreana Dransf.
P. pilosa (Burret) Dransf.
P. ridleyana Becc. ex Furtado
P. rivularis Becc.
P. salicifolia Bl.
P. tomentella Becc.
P. veitchii H. Wendl.
Plectocomia ?elongata Mart. ex Bl.
P. muelleri Bl.
Plectocomiopsis geminiflorus (Griff.) Becc.
P. triqueter (Becc.) Dransf.
Pogonotium divaricatum Dransf.
Retispatha dumatosa Dransf.
Salacca affinis Griff.
S. magnifica Mogea
S. rupicola Dransf.
S. vermicularis Becc.

PANDANACEAE

Freycinetia imbricata Bl.
F. javanica Bl. var. expansa Stone
F. palawanensis Elmer var. andersoniana Stone
F. rigidifolia Hemsl.
F. sarawakensis Martelli
F. sumatrana Hemsl.
F. winkleriana Martelli
Pandanus aff. brevistylis St.John ex Stone
P. calcinactus St.John ex Stone
P. dorystigma Martelli
P. ?epiphyticus Martelli
P. fusinus Martelli
P. aff. kamii Stone
P. lepatophilus Stone
P. microglottis Stone (ined.)
P. motleyanus Solms
P. pumilus St.John
P. rupestris Stone (ined.)
P. sylvaticus Stone

TACCACEAE

Tacca species indet.

TRIURIDACEAE

Sciaphila flexuosa Giessen

ZINGIBERACEAE

Achasma megalocheilos Griff.
Alpinia glabra Ridl.
Boesenbergia hutchinsonii B.L. Burtt & R. Smith
B. pulchella Ridl.
Costus aff. paradoxus K. Schum.
C. speciosus (Koenig) R. Smith
Geanthus fimbreobracteatus (K. Schum.) B.L. Burtt & R. Smith
Geostachys species indet.
Globba sanguinea Miq.

Magnoliophyta: Magnoliopsida

ACANTHACEAE

Borneacanthus grandifolius Brem.
Cosmianthemum magnolifolium Brem.
Hallieracantha caudata Stapf
H. aff. creaghii Stapf
H. salicifolia Stapf
Pseuderanthemum species indet.
Staurogyne aff. jaheri Brem.
S. setigera Nees

ALANGIACEAE

Alangium ebenaceum (C.B. Clarke) Harms
A. griffithii (C.B. Clarke) Harms
A. javanicum (Bl.) Wang
A. ridleyi King

AMARANTHACEAE

Cyathula prostrata (L.) Bl.

ANACARDIACEAE

Androtium astylum Stapf
Buchanania arborescens (Bl.) Bl.
B. aff. lucida Bl.
Campnosperma auriculatum (Bl.) Hook. f.
Dracontomelon costatum Bl.
D. dao (Blanco) Merr. & Rolfe
Drimycarpus racemosa Hook. f.
Gluta laxiflora Ridl.
Mangifera havilandii Ridl.
Melanochyla aff. beccariana Oliver
M. elmeri Merr.
M. oblanceolata Merr.
Melanorrhoea beccarii Engl.
M. macrocarpa Engl.
M. wallichii Hook. f.
Parishia maingayi Hook. f.
Pentaspadon motleyi Hook. f.
Solenocarpus philippinensis (Elmer) Kosterm.
Swintonia acuta Engl.
S. schwenkii Teijsm. & Binn.

ANNONACEAE

Anaxagorea borneensis (Becc.) J. Sinclair
Cyathocalyx havilandii Boerl.
C. magnificus Boerl.
Desmos dumosa (Roxb.) Safford
Disepalum anomalum Hook. f.
Enicosanthum coriaceum (Hook. f. & Thom.) Airy Shaw
Goniothalamus dolichocarpus Merr.
G. giganteus Hook. f. & Thom.
G. malayanus Hook. f.
G. suaveolens Becc.
G. tapis Miq.
G. umbrosus J. Sinclair
G. velutinus Airy Shaw
G. woodii Merr.
Meiogyne virginata (Bl.) Miq.
Mezzettia leptopoda (Hook. f. & Thom.) Oliver
Neouvaria acuminatissima (Miq.) Airy Shaw
Polyalthia canangioides (Zoll.) Boerl.
P. cauliflora Hook. f. & Thom. var. cauliflora
P. flagellaris (Becc.) Airy Shaw
P. hookeriana King
P. hypogea King
P. hypoleuca Hook. f. & Thom.
P. jenkinsii (Hook. f. & Thom.) Hook. f. & Thom.
P. motleyana (Hook. f.) Airy Shaw var. motleyana
P. motleyana var. glabrescens
P. rumphii (Bl.) Merr.
P. sumatrana (Miq.) Kurz
P. suaveolens Becc.

P. xanthopetala Merr.
Popowia pisocarpa (Bl.) Endl.
Pseuduvaria pamateonis (Miq.) J. Sinclair
Pyramidanthe aff. prismatica (Hook. f.) J. Sinclair
Sageraea lanceolata Miq.

APOCYNACEAE

Alyxia lucida Wall.
A. pilosa Miq.
Alstonia angustiloba Miq.
Chilocarpus denudatus Bl.
Dyera costulatus Hook. f.
Ervatamia sphaerocarpa (Bl.) Airy Shaw
Kopsia singaporensis Ridl.
Leuconotis anceps Jack

AQUIFOLIACEAE

Ilex cymosa Bl.
I. grandifolia Merr.
I. havilandii Loes.
I. laurocerasus Airy Shaw
I. sclerophylloides Loes.

ARALIACEAE

Aralidium pinnatifolium Miq.
Arthrophyllum diversifolium Bl.
A. rubiginosum Ridl.
Osmoxylon species indet.
Schefflera beccariana Harms
S. glaucophylla Frodin
S. gracilis (Miq.) Harms
S. lineamentorum Frodin
S. aff. longifructescens Elmer
S. lucida (King) Ridl.
S. verticillata Frodin

ARISTOLOCHIACEAE

Thottea species indet.

ASCLEPIADACEAE

Hoya parasitica Wall.

BALANOPHORACEAE

Balanophora elongata Bl.
B. papuana Schlechter
B. reflexa Becc.

BALSAMINACEAE

Impatiens platypetala Lindl.

BEGONIACEAE

Begonia baramensis Merr.
B. congesta Ridl.
B. conipila Irmsch.
B. pubescens Ridl.

BIGNONIACEAE

Deplanchea bancana (Scheff.) Steenis
D. glabra Steenis

BOMBACACEAE

Coelostegia borneensis Becc.
Durio acutifolius (Mast.) Kosterm.
D. affinis Becc.
D. dulcis Becc.
D. grandiflorus (Mast.) Kosterm. ex Soep.
D. graveolens Becc.
D. lanceolatus Mast.
D. oblongus Mast.
Neesia glabra Becc.

BURSERACEAE

Canarium caudatum King
C. denticulatum Bl.
C. littorale Bl.
C. merillii H.J. Lam
C. odontophyllum Miq.
Dacryodes costata (Benn.) H.J. Lam
D. incurvata (Engl.) H.J. Lam
D. macrocarpa H.J. Lam var. macrocarpa
D. nervosa Bl.
D. rugosa (Bl.) H.J. Lam var. virginata (Bl.) H.J. Lam
Santiria apiculata Benn. var. apiculata
S. apiculata var. pilosa (Engl.) Kalkm.
S. grandiflora Kalkm.
S. laevigata Bl.
S. megaphylla Kalkm.
S. oblongifolia Bl.
S. rubiginosa Bl. var. pedicellata

CAMPANULACEAE

Lobelia zeylanica L.
Pentaphragma acuminatum Airy Shaw
P. albiflorum H.H. Pears.
P. cyrtandriforme Airy Shaw
P. viride Stapf & Green

CAPPARIDACEAE

Crataeva nurvala Ham. var. nurvala

CASUARINACEAE

Casurina nobilis Whitmore

CELASTRACEAE

Bhesa paniculata Arn.
Celastrus monospermoides Loes.
Euonymus castaneifolius Ridl.
Kokoona ovatolanceolata Ridl.
Lophopetalum beccarianum Pierre
L. rigidum Ridl.
L. sessilifolium Ridl.
L. subobovatum King
Microtropis valida Ridl.
Perrottetia alpestris (Bl.) Loes. subsp. philippinensis (Vidal) Ding Hou
Siphonodon celastrineus Griff.

CHLORANTHACEAE

Chloranthus officinalis Bl.

CLETHRACEAE

Clethra clementis Merr.

COMBRETACEAE

Terminalia phellocarpa King
T. subspathulata King

COMPOSITAE

Gynura albicaulis W.W. Sm.
Vernonia arborea Ham.

CONNARACEAE

Agelaea borneensis (Hook. f.) Merr.
A. trinervis (Llanos) Merr.
Cnestis platantha Griff.
Rourea mimosoides (Vahl) Planch.

CONVOLVULACEAE

Erycibe crassipes Ridl. ex Hoogl.
E. glomerata Bl. subsp. angustifolia (Hall. f.) Hoogl.
Jacquemontia tomentella (Miq.) Hall. f. var. tomentosa van Oestr.
Merremia peltata (L.) Merr.

CORNACEAE

Mastixia eugenioides Bl.
M. philippinensis Wang
M. rostrata Bl.

CRYPTERONIACEAE

Dactylocladus stenostachys Oliver

CUCURBITACEAE

Trichosanthes trifoliata Merell

CUNONIACEAE

Weinmannia aphanoneura Airy Shaw

DAPHNIPHYLLACEAE

Daphniphyllum borneense Stapf

DATISCACEAE

Octomeles sumatrana Miq.

DILLENIACEAE

Dillenia excelsa (Jack) Gilg. var. excelsa
D. excelsa var. pubescens (Corner) Corner ex Masanne
D. suffruticosa (Griff.) Martelli
D. reticulata King

DIPTEROCARPACEAE

Anisoptera laevis Ridl.
A. marginata Korth.
A. reticulata Ashton
Cotylelobium burckii (Heim) Heim
C. malayanum Slooten
C. melanoxylon (Hook. f.) Pierre
Dipterocarpus acutangulus Vesq.
D. applanatus Slooten
D. apterus Foxw.
D. borneensis Slooten
D. caudiferus Merr.
D. crinitus Dyer
D. eurynchus Miq.
D. exalatus Slooten
D. humeratus Slooten
D. lowii Hook. f.
D. oblongifolius Bl.
D. pachyphyllus Meijer
D. palembanicus Slooten
D. sarawakensis Slooten
D. stellatus Vesq.
D. verrucosus Slooten
Dryobalanops aromatica Gaertn. f.
D. beccarii Dyer
D. lanceolata Burck
D. rappa Becc.
Hopea andersonii Ashton
H. argentea Meijer
H. dasyrrhachis Slooten
H. aff. dyeri Heim
H. fluvialis Ashton
H. mengarawan Miq.
H. mesuoides Ashton
H. nervosa King
H. nutans Ridl.
H. pachycarpa (Heim) Sym.
H. pentanervia Sym.
H. pterygota Ashton
H. sangal Korth.
H. treubii Heim
Parashorea macrophylla Wyatt Sm. ex Ashton
P. smythiesii Wyatt Sm. ex Ashton
Shorea acuta Ashton.
S. agami Ashton
S. albida Sym
S. [illegible] Foxw.
S. amplexicaulis Ashton
S. andulensis Ashton
S. angustifolia Ashton
S. argentifolia Sym.
S. atrinervosa Sym.
S. beccariana Burck
S. bracteolata Dyer

S. brunnescens Ashton
S. bullata Ashton
S. coriacea Burck
S. crassa Ashton
S. cristata Brandis
S. curtisii Dyer
S. dasyphylla Foxw.
S. domatiosa Ashton
S. faguetiana Heim
S. fallax Meijer
S. ferruginea Dyer ex Brandis
S. flava Meijer
S. flaviflora Wood ex Ashton
S. gibbosa Brandis
S. glaucescens Meijer
S. iliasii Ashton.
S. havilandii Brandis
S. laevis Ridl.
S. leprosula Miq.
S. leptocladus Sym.
S. macrophylla (De Vries) Ashton
S. macroptera Dyer
S. materialis Ridl.
S. maxwelliana King
S. monticola Ashton
S. multiflora (Burck) Sym.
S. myrionerva Wood ex Ashton
S. obscura Meijer
S. ochracea Sym.
S. ovalis (Korth.) Bl.
S. ovata Dyer ex Brandis
S. palembanica Miq.
S. parvifolia Dyer
S. parvistipulata Heim
S. patoiensis Ashton
S. pauciflora King
S. pilosa Ashton
S. pinanga Scheff.
S. platycarpa Heim
S. platyclados Slooten
S. quadrinervis Slooten
S. richetia Sym.
S. rubra Ashton
S. rugosa Heim
S. scaberrima Burck
S. scabrida Sym.
S. scrobiculata Burck
S. seminis (De Vries) Slooten
S. smithiana Sym.
S. superba Sym. ex Wood
S. teysmanniana Dyer,
S. venulosa Meijer
Vatica brunigi Ashton
V. coriacea Ashton
V. dulitensis Sym.

V. granulata Slooten
V. mangachapoi Blanco
V. oblongifolia Hook. f.
V. odorata (Griff.) Sym.
V. sarawakensis Heim

EBENACEAE

Diospyros borneensis Hiern
D. cauliflora Bl.
D. diepenhorstii Miq.
D. elliptifolia Merr. forma kinabaluensis Bakh.
D. evana Bakh.
D. ferruginescens Bakh.
D. frutescens Bl.
D. hermaphroditica (Zoll.) Bakh. ex Steenis
D. korthalsiana Hiern
D. multiflora Blanco
D. oblongata Wall. ex G. Don
D. pendula Hasselt. ex Hassk.
D. polyalthioides Hiern
D. undulata G. Don
D. wallichii King & Gamble ex King

ELAEOCARPACEAE

Elaeocarpus acrantherus Merr.
E. angustipes Knuth
E. beccarii DC.
E. clementis Merr. var. clementis
E. congestifolius Knuth
E. conoideus Knuth
E. euneurus Stapf ex Ridl.
E. ferrugineus (Jack) Steud. var. elliptifolius (Merr.) Weibel
E. floribundus Bl.
E. glaber Bl.
E. griffithii (Wight) A. Gray
E. hochreutineri Weibel
E. marginatus Stapf
E. mastersii King
E. multinervosus Knuth
E. muluensis Weibel
E. nitidus Jack
E. obtusus Bl.
E. pedunculatus Wall. ex Mast.
E. petiolatus Wall.
E. pseudopaniculatus Corner
E. sadikanensis Knuth
E. stipularis Bl.

ERICACEAE

Costera macrotheca Argent (ined.)
C. ovalifolia J.J. Sm.
C. tetramera Sleumer
Diplycosia acuminata Becc.
D. barbigera Sleumer
D. ciliolata Hook. f.
D. elliptica Ridl.
D. fimbriata Sleumer
D. heterophylla Bl. var. latifolia (Bl.) Sleumer
D. lavendulifolia Sleumer
D. microsalicifolia Argent (ined.)
D. pittosporifolia J.J. Sm.
D. salicifolia Sleumer
D. scabrida Becc.
Pernettyopsis megabracteata Argent (ined.)
Rhododendron broookeanum Lour. ex Lindl. subsp. brookeanum
R. brookeanum subsp. moultonii (Ridl.) Argent (ined.)
R. buxoides Sleumer
R. crassifolium Stapf
R. durionifolium Becc.
R. ericoides Low ex Hook. f.
R. exuberans (Sleumer) Argent (ined.)
R. himantodes Sleumer
R. lanceolatum Ridl.
R. longiflorum Lindl.
R. micromalayanum Sleumer
R. moultonii Ridl.
R. niewenhuisii J.J. Sm.
R. orbiculatum Ridl.
R. quadrasianum Vid. var. angustissimum Sleumer
R. rugosum Low ex Hook. f.
R. suaveolens Sleumer
R. yongii Argent (ined.)
Vaccinium andersonii Sleumer
V. bancanum Miq.
V. borneense W.W. Sm.
V. claoxylon J.J. Sm.
V. clementis Merr.
V. coriaceum Miq.
V. kemulense Sleumer
V. leptanthum Miq.
V. megaphyllum Sleumer var. megaphyllum
V. monanthum Ridl.
V. pachydermum Stapf
V. sulcatum Ridl.
V. tenax Argent (ined.)
V. tenerellum Sleumer
V. uniflorum J.J. Sm.

ERYTHROXYLACEAE

Erythroxylum cuneatum (Miq.) Kurz

ESCALLONIACEAE

Polyosma bracteosum Stapf
P. hookeri Stapf
P. integrifolia Bl.
P. latifolia Schlechter
P. mjobergii Merr.

EUPHORBIACEAE

Agrostistachys longifolia (Wight) Benth. ex Hook.
Antidesma atatum Hook. f.
A. hosei Pax & Hoffm.
A. montanum Bl.
A. neurocarpum Miq.
A. tomentosum Bl. var. tomentosum
Aporusa benthamiana Hook. f.
A. caloneura Airy Shaw
A. granularis Airy Shaw
A. lunata (Miq.) Kurz
A. subcaudata Merr.
Austrobuxus nitidus Miq.
Baccaurea angulata Merr.
B. bracteata Muell. Arg.
B. costulata Muell. Arg.
B. lanceolata (Miq.) Muell. Arg.
B. latifolia King ex Hook. f.
B. maingayi Hook. f.
B. minor Hook. f.
B. motleyana (Muell. Arg.) Muell. Arg.
B. parviflora (Muell. Arg.) Muell. Arg.
B. pyriformis Gage
B. racemosa (Reinw.) Muell. Arg.
B. sumatrana (Miq.) Muell. Arg.
B. trigonocarpa Merr.
B. trunciflora Merr.
Blumeodendron kurzii (Hook. f.) J.J. Sm.
B. tokbrai (Bl.) Kurz
Bridelia adusta Airy Shaw
B. glauca Bl.
B. penangiana Hook. f.
Chephalomappa malbricarpa Airy Shaw
Chaetocarpus castanocarpus (Roxb.) Thwaites
Claoxylon stapfianum Airy Shaw
Cleidion javanicum Bl.
Cleistanthus brideliifolius C.B. Rob.
C. glaber Airy Shaw
C. myrianthus (Hassk.) Kurz
C. sumatranus (Miq.) Muell. Arg.
Croton argyratus Bl.
C. oblongus Burm. f.
Drypetes longifolia (Bl.) Pax & Hoffm.
D. microphylla (Merr.) Pax & Hoffm.
D. sibuyanensis (Elmer) Pax & Hoffm.

Elateriospermum tapos Bl.
Endospermum peltatum Merr.
Euphorbia aff. luzoniensis Merr.
Excoecaria borneensis Pax & Hoffm.
Glochidion calospermum Airy Shaw
G. lutescens Bl.
G. macrostigma Hook. f.
G. obscurum (Roxb. ex Willd.) Bl.
G. rubrum Bl.
G. sericeum (Bl.) Zoll.
Homalanthus populneus (Geisel.) Pax
Macaranga anceps Airy Shaw subsp. puncticulata Whitmore
M. beccariana Merr.
M. brevipetiolata Airy Shaw
M. caladiifolia Becc.
M. calcicola Airy Shaw
M. conifera (Zoll.) Muell. Arg.
M. hosei King ex Hook. f.
M. hypoleuca Mueller
M. kingii Hook. f. var. platyphylla Airy Shaw
M. pruinosa (Miq.) Muell. Arg.
M. trachyphulla Airy Shaw
M. triloba (Bl.) Muell. Arg.
M. winkleriella Whitmore
Mallotus dispar (Bl.) Muell. Arg.
M. lackeyi Elmer
M. macrostachyus (Miq.) Muell. Arg.
M. oblongifolius (Miq.) Muell. Arg.
M. penangensis Muell. Arg.
M. wrayi King ex Hook. f.
Moultonianthus leembruggianus (B. & K.) Steenis
Neoscortechinia forbesii Pax ex S. Moore
N. kingii (Hook. f.) Pax & Hoffm.
N. sumatrensis S. Moore var. sumatrensis
Omphalea malayana Merr.
Phyllanthus chamaepece Ridley
Pimelodendron griffithianum (Muell. Arg.) Benth.
Ptychopyxis arborea (Merr.) Airy Shaw
P. aff. caput-medusae Miq.
Suregada multiflora Juss.
Trigonopleura malayana Hook. f.
Trigonostemon malaccanus Muell. Arg.

FAGACEAE

Castanopsis foxworthyi Schottky
C. motleyana King
Lithocarpus andersonii Soepadmo
L. bennettii (Miq.) Rehd.
L. cantleyanus (King ex Hook. f.) Rehd.
L. confertus Soepadmo
L. conocarpus (Oudem.) Rehd.
L. encleisacarpus (Korth.) A. Camus
L. gracilis (Korth.) Soepadmo

L. hatusimae Soepadmo
L. lampadarius (Gamble) A. Camus
L. leptogyne (Korth.) Soepadmo
L. luteus Soepadmo
L. nieuwenhuisii (Steenis) A. Camus
L. nodosus Soepadmo
L. papillifer Hatus. ex Soepadmo
L. psudokunstleri A. Camus
L. pulcher (King) Margraf
L. pusillus Soepadmo
L. revolutus Hatus. ex Soepadmo
L. sundaicus (Bl.) Rehd.
L. turbinatus (Stapf) Forman
Quercus argentata Korth.
Q. elmeri Merr.
Q. subsericea A. Camus
Q. validinervosa Soepadmo

FLACOURTIACEAE

Casearia capitellata Bl.
Flacourtia rukam Zoll.
Homalium foetidum (Roxb.) Benth.
Hydnocarpus woodii Merr.
Pangium edule Reinw. ex Bl.
Ryparosa acuminata Merr.
R. javanica (Bl.) Kurz
Scolopia spinosa (Roxb.) Warb.

GENTIANACEAE

Cotylanthera tenuis Bl.

GESNERIACEAE

Aeschyanthus parvifolius R. Br.
A. tricolor Hook.
Agalmyla borneensis (Schlechter) B.L. Burtt
A. erecta B.L. Burtt
A. johnannis-winkleri (Kraenzl.) B.L. Burtt
Boea treubii Forbes
Cyrtandra argentata subsp. latifolia B.L. Burtt (ined.)
C. benaratica B.L. Burtt
C. bracheia B.L. Burtt
C. digitaliflora B.L. Burtt
C. aff. gibbsiae S. Moore
C. incrustata (Bl.) B.L. Burtt
C. lacerata B.L. Burtt
C. multibracteata C.B. Clarke
C. oblongifolia (Bl.) C.B. Clarke
C. penduliflora Kraenzl.
C. radiciflora C.B. Clarke

C. splendens C.B. Clarke
C. trisepala C.B. Clarke
C. uniflora B.L. Burtt
C. woodsii B.L. Burtt
Didissandra anisanthera B.L. Burtt
Didymocarpus simplex Kraenzl.
Epithema involucratum (Roxb.) B.L. Burtt
Loxocarpus conicapsularis (C.B. Clarke) B.L. Burtt
L. repens B.L. Burtt
L. verbeniflos (C.B. Clarke) B.L. Burtt
Monophyllaea andersonii B.L. Burtt
M. beccarii C.B. Clarke
M. cupiflora B.L. Burtt var. cupiflora
M. cupiflora var. aggregata B.L. Burtt
M. fissilis B.L. Burtt
M. horsfieldii R. Br.
M. hottae B.L. Burtt
M. insignis B.L. Burtt var. insignis
M. insignis var. rubriflora B.L. Burtt
M. johannis-winkleri Kraenzl.
M. merrilliana Kraenzl.
M. pendula B.L. Burtt
Paraboea banyengiana B.L. Burtt
P. caudidissima B.L. Burtt
P. clarkei B.L. Burtt
P. effusa B.L. Burtt
P. meiophylla B.L. Burtt

GONYSTYLACEAE

Gonystylus acuminatus Airy Shaw
G. bancanus (Miq.) Kurz
G. borneensis Airy Shaw
G. brunnescens Airy Shaw
G. calophylloides Airy Shaw
G. forbesii Gilg.
G. nervosus Airy Shaw
G. velutinus Airy Shaw

GOODENIACEAE

Scaevola micrantha Presl

GUTTIFERAE

Calophyllum biflorum Hend. & Wyatt-Sm.
C. curtisii King
C. elegans Ridl.
C. ferrugineum Ridl.
C. garcinioide P.F. Stevens (ined.)
C. hosei Ridl.
C. inophylloide King

C. pulcherrimum Wall. ex Planch. & Trian.
C. nodosum Vesq.
C. teysmannii Miq. var. inophylloice
Cratoxylum arborescens (Vahl) Bl.
C. formosum (Jack) Dyer subsp. formosum
Garcinia apetala Pierre
G. beccarii Pierre
G. benthamiana Pierre
G. blumei Pierre
G. borneensis Pierre
G. brevipes Pierre
G. calophyllifolia Ridl.
G. caudiculata Ridl.
G. cuneifolia Pierre
G. cuspidata King
G. divers King
G. dryobalanoides Pierre
G. dulcis Pierre
G. gaudichaudii Planch. & Trian.
G. hombroniana Pierre
G. maingayi Hook. f.
G. memecycloides Ridl.
G. miquelii Pierre
G. nitida Pierre
G. parvifolia (Miq.) Miq.
G. petiolaris Pierre
G. rostrata Hassk.
G. sarawakensis Pierre
G. vidua Ridl.
Mammea anastomosans (Miq.) Kosterm.
M. calciphila Kosterm.
M. reticulata Kosterm.
Mesua acuminatissima (Merr.) Kosterm.
M. calophylloides (Ridl.) Kosterm.
M. elmeri (Merr.) Kosterm.
M. grandis (King) Kosterm.
M. myrtifolia (Baill.) Kosterm.

ICACINACEAE

Gomphandra cumingiana (Miers) F. Vill.
Phytocrene racemosa Sleumer
Platea latifolia Bl.
Stemonurus malaccensis (Mast.) Sleumer
S. scorpioides Becc.
S. umbellatus Becc.

JUGLANDACEAE

Engelhardtia serrata Bl.

LABIATAE

Gomphostemma javanica Benth.
G. . microcalyx Prain

LAURACEAE

Actinodaphne borneensis Meissn.
A. glomerata Nees
A. myriantha Merr.
A. pruinosa Nees
Alseodaphne bancana Miq.
A. insignis Gamble
A. rubrolignea Kosterm.
Beilschmiedia gemmiflora Kosterm.
B. glabra Kosterm.
B. glauciphylla Kosterm.
B. madang Bl.
B. maingayi Hook. f.
B. micrantha Merr.
B. palembanica (Miq.) Kosterm.
B. perakensis Gamble
B. phoebeopsis Kosterm.
B. pilosa Kosterm.
Cinnamomum caudifolium Kosterm.
C. iners Reinw. ex Bl.
C. microcarpum Kosterm.
Cryptocarya cagayensis Merr.
C. kurzii Hook. f.
C. laevigata Bl.
C. tawaensis Merr.
Dehaasia cuneata Bl.
D. firma Bl.
D. incrassata (Jack) Kosterm.
D. membranacea Kosterm.
Endiandra coriacea Merr.
Eusideroxylon melagangai Sym.
E. zwageri T. & B.
Lindera bibracteata (Bl.) Boerl. var. rufa (Stapf) Kosterm.
L. caesia Reinw. ex Vill.
L. rufa Gamble
L. subumbellifera (Bl.) Kosterm.
Litsea accedens (Bl.) Boerl.
L. cordata (Jack) Hook. f.
L. 'caulocarpa Merr.
L. cylindrocarpa Gamble
L. elliptibacca Merr.
L. erectinervia Kosterm.
L. ficoidea Kosterm.
L. firma (Bl.) Hook. f.
L. fulva Vill.
L. grandis Hook. f.
L. lancifolia Vill.
L. lanceolata (Bl.) Kosterm.

L. machilifolia Gamble
L. nigricans (Meissn.) Boerl.
L. ochracea Boerl.
L. oppositifolia (Bl.) Vill.
L. petiolata Hook. f.
L. varians (Bl.) Boerl.
Nothaphoebe havilandii Gamble
N. heterophylla Merr.
N. macrantha Kosterm.
Phoebe declinata Bl.
P. sterculioides Elmer

LECYTHIDACEAE

Barringtonia lanceolata (Ridl.) Payens
B. revoluta Merr.

LEEACEAE

Leea aculeata Bl.

LEGUMINOSAE

Cassia alata L.
Copaifera palustris (Sym.) De Wit
Crudia reticulata Merr. ex De Wit
Dalbergia havilandii Prain
Derris elegans (Grah.) Benth.
D. malaccensis (Benth.) Planch.
Dialium cochinchinense Pierre
D. indum L.
D. laurinum Baker
D. sylvestre De Wit
Fordia filipes Dunn
F. johorensis Whitmore
Koompassia excelsa (Becc.) Taubert
K. malaccensis Maingay ex Benth.
Mastersia borneensis Harms.
Mezoneurum sumatranum (Roxb.) Wight & Arn.
Mucuna biplicata T. & B.
Parkia sumatrana Miq.
Phanera argentea De Wit
P. bidentata (Jack) Benth.
P. kockiana (Korth.) Benth. var. kockiana
Pithecellobium borneense Benth.
P. clypearia (Jack) Benth.
P. motleyana Jack
P. oppositum Miq.
Saraca declinata (Jack) Miq.
Sindora coriacea Maingay ex Prain
S. irpicina De Wit
S. leiocarpa Backer ex K. Heyne
Whitfordiodendron myranthum (Dunn) Merr.

LENTIBULARIACEAE

Utricularia striatula Sm.

LINACEAE

Ctenolophon parvifolius Oliver
Ixonanthes beccarii Hall.

LOGANIACEAE

Fagraea auriculata Jack subsp. borneensis (Scheff.) Leen.
F. blumei G. Don
F. ceilanica Thunb.
F. elliptica Roxb.
F. fragrans Roxb.
F. racemosa Jack ex Wall.
Strychnos ovata Hill

LORANTHACEAE

Barathranthus axanthus (Korth.) Miq.
Dendropthoe falcata Bl.
Elytranthe albida (Bl.) Bl.
Helixanthera xestophylla (Miq.) Danser
H. maxwelliana (Gibbs) Danser
Lepeostegeres inconspicuus Danser
L. lanceifolius v. Tieghen
Lepidaria bicarnata v. Tieghen
Loxanthera speciosa Bl.
Macrosolen beccarii Becc.
Scurrula ferruginea (Jack) Danser
Trithecanthera xiphostachys v. Tieghen

MAGNOLIACEAE

Aromadendron elegans Bl.
A. nutans Dandy
Magnolia maingayi King
Michelia species indet.
Talauma gigantifolia Miq.

MELASTOMATACEAE

Anerincleistus beccarii Cogn.
A. glomeratus King
A. ovatus Ridl.
Astronia cumingiana Vidal
Blastus cogniauxii Stapf
Dalenia pubescens Merr.

Dissochaeta glandulosa Merr.
Driessenia axanthe Korth.
D. glanduligera Stapf
Kibessia azurea (Bl.) DC.
K. galeata (Bl.) Cogn.
K. gracilis Cogn.
K. korthalsiana Cogn.
K. verrucosa Merr.
Marumia pachygyna Korth.
Medinilla crassifolia (Reinw. ex Bl.) Bl.
M. cuspidata Bl.
M. muricata Bl.
M. radicans (Bl.) Bl.
M. robusta Cogn.
M. scandens King
M. speciosa Bl.
Melastoma beccarianum Cogn.
M. decemfidum Roxb.
M. molle Korth. var. parva
M. muticum Ridl.
M. sanguineum Sime
Memecylon acuminatum Sm.
M. beccarianum Cogn.
M. borneense Merr.
M. costatum Miq.
M. crassifolium Bl.
M. edule Roxb.
M. elmeri Merr.
M. garcinioide Bl.
M. globosum Bakh. f.
M. laevigatum Bl.
M. laurinum Bl.
M. ovatum Sm.
M. scolopacinum Ridl.
Neodissochaeta celebica Nayar
Neodriessenia species indet.
Orthocharis species indet.
Pachycentria microsperma Becc.
P. tuberculata Korth.
Phaulanthus acuminatissimus Ridl.
Phyllagathis elliptica Stapf
Plethiandra hookeri Stapf
P. motleyi Hook. f.
Pomatostoma sertuliferum (Becc.) Stapf
Pternandra caerulescens Jack
Sonerila beccariana Cogn.
S. pulchella Stapf
S. purpurascens Cogn.
S. tenuifolia Bl.
Tayloriphyton glabrum Nayar

MELIACEAE

Aglaia affinis Merr.
A. bernardoi Merr.
A. borneensis Merr.
A. brachybotrys Merr.
A. chaudocensis Pierre
A. cordata Hiern
A. cuspidella Ridl.
A. havilandii Ridl.
A. harmsiana Parkin.
A. odoratissima Bl.
A. palembanica Miq.
A. polyantha Ridl.
A. rufa Miq.
A. shawiana Merr.
A. trichostemon C. DC.
A. trimera Ridl.
A. triplex Ridl.
A. unifoliata Ridl.
Amoora rubiginosa Hiern
Aphanamixis borneensis (Miq.) Harms
A. grandifolia Walp. ex DC.
Azadirachta excelsa (Jack) Jacobs
Chisocheton beccarianum (Baill.) Harms
C. ceramicus (Miq.) C. DC.
C. macranthus (Merr.) Airy Shaw
Dysoxylon acutangulum Miq.
D. alliaceum Bl.
D. cauliflorum Hiern
D. macrocarpum Bl.
D. rubrum Merr.
D. thyrsoideum Griff.
D. undulatum Bl.
Sandoricum borneense Miq.
S. koejape (Burm. f.) Merr.
S. maingayi Hiern

MENISPERMACEAE

Tinospora hirsuta (Becc.) Forman

MONIMIACEAE

Matthaea sancta Bl.

MORACEAE

Artocarpus anisophyllus Miq.
A. dadah Miq.
A. elasticus Reinw. ex Bl.
A. lanceifolius Roxb.
A. nitidus Trec.
A. odoratissimus Blanco

A. ovatus Blanco
A. rigidus Bl.
Ficus binnendijkii Miq.
F. callicarpus Corner
F. chartacea Wall. ex King
F. deltoidea Jack var. deltoidea
F. deltoidea var. borneensis Corner
F. deltoidea var. intermedia Corner
F. deltoidea var. kinabaluense Corner
F. deltoidea var. lutescens (Desf.) Corner
F. eumorpha Corner
F. francisci Winkler
F. geocharis Corner
F. hemsleyana King
F. heteropleura Bl.
F. lamponga Miq.
F. lepicarpa Bl. var. brevibracteata Corner
F. leptogramma Corner
F. macilenta King
F. microcarpa L.f.
F. midotis Corner
F. oleaefolia King var. memecylifolia Corner
F. oleaefolia var. myrsinoides Corner
F. oleaefolia var. oddonaeformis Corner
F. paracamptophylla Corner
F. punctata Thunb.
F. rubrocuspidata Corner
F. rubromidotis Corner
F. schwarzii Koord
F. spathulifolia Corner
F. spiralis Corner
F. subulata Miq.
F. sumatrana Miq.
F. tinctoria Forst. f. subsp. gibbosa (Bl.) Corner
F. uniglandulosa Wall. var. parviflora Miq.

MYRICACEAE

Myrica esculenta Buch.-Ham.
M. javanica Bl.

MYRISTICACEAE

Gymnacranthera contracta Warb.
G. eugeniifolia (DC.) var. griffithii (Warb.) J. Sinclair
G. forbesii (King) Warb. var. crassinervis (Warb.) J. Sinclair
Horsfieldia bracheata (King) Warb. var. sumatrana (Miq.) J. Sinclair
H. bracteosa Hend. var. microcarpa J. Sinclair
H. crassifolia (Hook. f. & Thom.) Warb.
H. glabra (Bl.) Warb.
H. montana Airy Shaw
H. polyspherula (Hook. f. emend. King) J. Sinclair

E. barringtonioides Ridl.
E. beccarii Ridl.
E. castanea Merr.
E. caudatilimba Merr.
E. cerina Hend.
E. chlorantha Duthie
E. chrysantha Merr. & Perry
E. corymbifera Koord. & Valeton
E. curtisii King
E. densiflora (Bl.) DC.
E. elliptilimba Merr.
E. fastigiata
E. glanduligera Ridl.
E. grandis Wight
E. havilandii Merr.
E. heteroclados Merr.
E. hirta Korth.
E. kinabaluensis Stapf
E. kunstleri King
E. leucoxylon (Korth.) Miq.
E. lineata (Bl.) Duthie
E. monantha Merr.
E. multibracteolata Merr.
E. napiformis
E. nemstrina Hend.
E. nitida Korth.
E. oblata Roxb.
E. ochneocarpa Merr.
E. ovatifolia Merr. & Perry
E. palawaensis C.B. Rob.
E. palembanica (Miq.) Merr.
E. punctilimba Merr.
E. rhynchophylla Merr.
E. rosulenta Ridl.
F. quadribracheata Hend.
E. sarawacensis Merr.
E. steenisii Merr. & Perry
E. subdecussata Duthie
E. subrufa King
E. tawaensis Merr.
E. villamilii Merr.
E. viridifolia Elmer
E. zeylanica (L.) Wight
Leptospermum flavescens Sm.
Rhodamnia cinerea Jack
Tristania bilocularis Stapf
T. beccarii Ridl.
T. clementis Merr.
T. obovata R. Br.
T. whiteana Griff.
Whiteodendron moultonianum (W.W. Sm.) Steenis
Xanthomyrtus flavida (Stapf) Merr.

NEPENTHACEAE

Nepenthes ampullaria Jack
N. bicalcarta Hook. f.
N. fusca Danser
N. gracilis Korth.
N. lowii Hook. f.
N. muluensis M. Hotta
N. rafflesiana Jack
N. stenophylla Merr.
N. tentaculata Hook f.
N. veitchii Hook. f.

NYMPHAEACEAE

Barclaya motleyi Hook.
B. rotundifolia M. Hotta

OCHNACEAE

Euthemis leucocarpa Jack
E. minor Jack
Gomphia serrata (Gaertn.) Kanis
Neckia serrata Korth.

OLACACEAE

Ochanostachys amentacea Mast.
Olax species indet.
Scorodocarpus borneensis Becc.
Strombosia aff. javanica Bl.
S. latifolila Stapf
S. rotundifolia King

OLEACEAE

Jasminum crassifolium Bl.
Linociera cuspidata (Bl.) Knobl.
L. evenia Stapf
L. oligantha Merr.
L. paludosa King & Gamble
L. pluriflora Knobl.
L. ramiflora (Roxb.) Koord.
L. spicifera Ridl.
Myxophyrum inerve Steenis
Olea species indet.

PETROSAVIACEAE

Petrosavia stellaris Becc.

PIPERACEAE

Peperomia species indet.
Piper arborescens Roxb. var. arborescens
P. arborescens var. hirtellum (Miq.) Merr.
P. aff. caninum Bl.
P. kurzii Ridl.
P. muricatum Bl.
P. porphyrophyllum N.E. Br.
P. ramifolium C. DC.
P. vestitum C. DC.

POLYGALACEAE

Epirixanthes cylindrica Bl.
E. elongata Bl.
Polygala venenosa Juss. ex Poir.
Xanthophyllum cordatum Korth. ex Miq.
X. discolor Chodat
X. ecarinatum Chodat
X. ellipticum Korth. ex Miq.
X. ellipticum Korth. ex Miq. var. subcoriaceum
X. ferrugineum Meijden
X. flavescens Roxb.
X. griffithii Hook. f. ex Benn.
X. macrophyllum Baker
X. ovatifolium Chodat
X. purpureum Ridl.
X. stipitatum Benn.
X. subcoriaceum (Chodat) Meijden

PROTEACEAE

Helicia fuscotomentosa Suess.
H. petiolaris Benn.
H. robusta (Roxb.) R. Br. ex Wall.

RAFFLESIACEAE

Rhizanthes lowii

RANUNCULACEAE

Clematis smilacifolia Wall.

RHAMNACEAE

Alphitonia moluccana Teijsm. & Binn. ex Braid
Rhamnus nepalensis Laws.
Zizyphus grewioides (Ward.) Perry
Z. havilandii Ridl.
Z. horsfieldii Miq.

RHIZOPHORACEAE

Anisophyllea corneri Ding Hou
A. disticha (Jack) Baillon
A. ferruginea Ding Hou
Carallia brachiata (Lour.) Merr.
C. borneensis Oliver
C. coriifolia Ridl.
Combretocarpus rotundatus (Miq.) Danser

ROSACEAE

Acioa heteropetala Kosterm.
Licania splendens (Korth.) Prance & Kosterm.
Parastemon spicatum Ridl.
P. urophyllum (DC.) DC.
Parinari species indet.
Prunus arborea (Bl.) Kalkm. var. arborea
P. arborea var. densa (King) Kalkm.
P. arborea var. stipulacea (King) Kalkm.
P. oocarpa (Stapf) Kalkm.
P. turfosa Kalkm.
Rubus glomeratus Bl.
R. moluccanus L.

RUBIACEAE

Acranthera frutescens Valeton
A. involucrata Valeton
A. aff. longipetiolata Merr.
Anthocephalus cadambe (Roxb.) Miq.
Argostemma brachyantherum Stapf
A. borragineum Bl.
A. elatostemma Maingay ex Hook. f. forma obovatum King
A. gracile Stapf
A. haemeliaefolia Wernh.
A. havilandii Ridl.
A. aff. inaequale Benn.
A. ophirense Maingay ex Hook. f.
A. parvifolia Benn. var. involucratum (Hemsl.) Bakh. f.
A. psychotrioides Ridl.
Canthium confertum Korth.
C. didymum Gaertn. f.
Cephalis stipulacea Bl.
Chassalia curviflora Thw.
Diplospora beccariana King
Gaertnera maginana (DC.) Merr. subsp. junghuhniana (Miq.) van Beusekom
Gardenia tubifera Wall.
Geophila (L.) Pearson
Gonyanera species indet.
Hedyotis rigida (Bl.) Miq.
Hydnophytum formicarium Jack

Ixora bavica Brem.
I. aff. brachyanthera Brem.
I. aff. caudata Brem.
I. flagrans Brem.
I. glomeruliflora Brem.
I. grandifolia Zoll. & Mor.
I. griffithii Hook.
I. lancisepala Ridl.
I. polycephala Brem.
Lasianthus aff. borneensis Merr.
L. constrictus Wight
L. gracilipes Ridl.
L. griffithii Wight
L. inaequalis Bl.
L. longifolius Wight
L. maingayi Hook. f.
L. pilosus Wight
L. robinsonii Ridl.
L. stiupularis Bl.
Lucinaea membranacea King
L. nervulosa Stapf
L. pentacme Stapf
L. ridleyi King
Maschalocorymbus species indet.
Mitreola sphaerocarpa Leenh.
Mussaendopsis beccariana Baill.
Mycetia javanica (Bl.) Korth.
Myrioneuron cyaneum Hall.
Myrmecodia tuberosa Jack
Myrmeconauclea strigosa (Korth.) Merr.
Nauclea calycina Bartt.
N. subdita (Korth.) Merr.
N. synkorynos Korth.
Neonauclea peduncularis Walp. ex G. Don
N. strigosa Korth.
Ophiorrhiza axillaris Ridl.
O. communis Ridl.
O. fibrillosa Ridl.
O. havilandii Ridl.
O. winkleri Valeton
Pavetta axillaris Brem.
P. aff. mirabilis Brem.
P. petiolaris Craib ex Brem.
P. sarawacensis Brem.
Pleiocarpidia cephalotes (Ridl.) Brem.
P. enneandra (Wright) K. Schum.
P. sendahanica Brem.
Porterandia anisophylla (Jack ex Roxb.) Ridl.
Prarevinia borneensis (Merr.) Brem.
P. serichotricha Brem.
Prismatomeris lepidophloia (Miq.) Ridl.
P. tetrandera (Roxb.) K. Schum.
Proscephaleium aff. javanicum Korth.
Psychotria crassifolia Miq.
P. densifolia Stapf

P. elegans Ridl.
P. elmeri Merr.
P. aff. iteophylla Stapf
P. laxiflora Bl.
P. nieuwenhuisii Valeton
P. pachyphylla Ridl.
P. ?sarmentosa Bl.
Randia beccariana Baill.
R. kuchingensis W.W. Sm.
Rennellia ?elongata (King & Gamble) Ridl.
R. speciosa Hook. f.
Steenisia pterosepala (Airy Shaw) Bakh. f.
Streblosa bracteata Ridl.
S. aff. myriocarpa (Merr. & Clav.) Brem.
Tarenna aff. arborea (Elmer) Elmer
T. crassifolia Ridl.
T. cumingiana (Vidal) Elmer
T. fragrans (Bl.) Koord. & Valeton
Timonius borneensis Valeton
T. compressicaulis (Miq.) Boerl.
T. eskerianus W.W. Sm.
T. flavescens (Jack) Baker
T. lasianthoides Valeton
T. matangensis Valeton
Uncaria acida (Hunt) Roxb.
U. cordata (Lour.) Merr. var. ferruginea (Bl.) Ridsdale
U. ferrea DC.
Urophyllum arboreum Korth.
U. congestiflorum Ridl.
U. aff. hirsutum Hook. f.
U. neriifolium Ridl.
U. nigricans Wernh.
U. pellacalyx Ridl.
U. salicifolium Stapf
U. woodii Merr.
Xanthophytum grandifolium Valeton ex Bakh. f.
X. involucratum Merr.

RUTACEAE

Acronychia porteri Hook. f.
Euodia punctata Merr.
Lunasia amara Blanco
Luvunga crassifolia Tanaka
L. motleyi Oliver
Meliocope triphylla DC.
Micromelum minutum (Forst. f.) Wight & Arn.
Pleiospermum latiolatum Swingle
Tetractomia species indet.

SABIACEAE

Meliosma rufo-pilosa Hend.
M. sumatrana (Jack) Walp.

SYMPLOCACEAE

Symplocos crassipes C.B. Clarke var. ernae (Brand.) Noot.
S. fasciculata (Wall.) Zoll.
S. odoratissima (Bl.) Choisy ex Zoll.
S. pendula Wight var. confusa (Brand.) Noot.

TETRAMERISTACEAE

Tetramerista? glabra Miq.

THEACEAE

Adinandra acuminata Korth.
A. clemensiae Kobuski
A. cordifolia Ridl.
A. dasyantha Korth.
A. dumosa Jack
A. sarcosanthera Miq.
Cordyoblaste species indet.
Gordonia havilandii Burkill
G. lanceifolia Burkill
Pyrenaria kunstleri King
Schima wallichii (DC.) Korth.
Ternostroemia aneura Miq.
T. beccarii Stapf ex Ridl.
T. citrina Ridl.
T. denticulata (Pierre) Ridl.
T. macrocalyx Airy Shaw
T. magnifica Stapf ex Ridl.

THYMELAEACEAE

Amyxa pluricornis (Radlk.) Domke
Aquilaria malaccensis Lamk.
A. microcarpa Baill.
Wikstroemia indica (L.) C.A. Mey.
W. ovata C.A. Mey. ex Meisch.
W. tenuiramis Miq.

TILIACEAE

Brownlowia glabrata Stapf ex Ridl.
B. peltata Benth.
Grewia cinnamomifolia Stapf ex Burret
G. fibrocarpa Mast.
G. latifolia Mast.
G. omphacarpa Miq.
G. ossea Burret
G. paniculata Roxb.
Pentace corneri Kosterm.
P. rigida Kosterm.

TRIGONIACEAE

Trigoniastrum hypoleucum Miq.

ULMACEAE

Gironniera nervosa Planch.
G. subaequalis Planch.

URTICACEAE

Boehmeria malabarica Wedd.
Dendrocnide stimulans (L. f.) Chew
Elatostema acuminata (Poir.) Brongn.
E. variolaminosum Schr. var. latum
E. sesquifolium (Bl.) Hassk.
Leucosyke capitellata (Poir.) Wedd.
Pilea calcarea Ridl.
P. fruticosa Hook. f.
Pipturus argenteus (Forst.) Wedd.
P. repandus Bl.
Poikilospermum cordifolium (Barg.-Petr.) Merr.
P. oblongifolium Merr.
P. scabrinervium Merr.
P. suaveolens (Bl.) Merr.

VERBENACEAE

Callicarpa involucrata Merr.
Clerodendrum myrmecophilum Ridl.
C. squamatum Vahl
Gmelina uniflora Stapf
Hoseanthus lobbii (C.B. Clarke) Ridl.
Petraeovitex species indet.
Premna oblongifolia Merr.
Teijsmanniodendron bogoriense Koord.
T. glabrum Merr.
T.. hollrungii (Warb.) Kosterm.
T. holophyllum (Backer) Kosterm.
T. pteropodum (Miq.) Bakh.
T. sarawakanum (Pears.) Kosterm.
Vitax pubescens Vahl

VIOLACEAE

Rinorea bengalensis (Wall.) O. Kuntze
R. horneri (Korth.) O. Kuntze

SANTALACEAE

Dendrotrophe buxifolia (Bl.) Merr.
D. varians (Bl.) Miq.
Scleropyrum wallichianum (Wight & Arn.) Arn.

SAPINDACEAE

Allophyllus cobbe (L.) Reusch.
Arytera littoralis Bl.
Dimocarpus longan Lour. var. malesiana Leenh.
Guioa bijuga (Hiern) Radlk.
G. pubescens (Zoll. & Mor.) Radlk.
Harpullia arborea (Blanco) Radlk.
H. cupanioides Roxb.
Lepisanthes amoena (Hassk.) Leenh.
L. fruticosa (Roxb.) Leenh.
L. tetraphylla (Vahl) Radlk.
Mischocarpus species indet.
Nephelium beccarianum Radlk.
N. lappaceum L.
N. maingayi Hiern
N. mutabile Bl.
N. uncinatum Radlk.
Paranephelium nitidum King
Pometia pinnata Forst. var. alnifolia (Hook. f.) Jacobs
Tristiropsis ferruginea Leenh.
Xerospermum intermedium Radlk.

SAPOTACEAE

Ganua kingiana (Brace) v.d. Asse
G. palembanica (Miq.) v.d. Asse & Kosterm.
G. prolixa Pierre ex Dubard
Isonandra lanceolata Wight var. lanceolata
Maduca korthalsii (Pierre) H.J. Lam
M. kunstleri (Brace) H.J. Lam
M. malaccensis (C.B. Clarke) H.J. Lam
M. sandakanensis Royen
Mimosops elengi L.
Palaquium decurrens H.J. Lam
P. gutta (Hook. f.) Baill.
P. leiocarpum Boerl.
P. longipedicellata Pierre
P. pseudocuneatum H.J. Lam
P. pseudorostratum H.J. Lam
P. ridleyi King & Gamble
P. rioense H.J. Lam
P. rostratum (Miq.) Burck
P. sericeum H.J. Lam
P. stipulare Pierre ex Dubard
P. walsuraefolium Pierre ex Dubard

Payena lucida (G. Don) DC.
P. obscura Burck
Planchonella obovata (R. Br.) Pierre
Pouteria malaccensis (C.B. Clarke) Baehni

SAURAUIACEAE

Saurauia acuminata Merr.
S. glabra Merr.
S. heterosepala Merr.
S. horrida Hook. f. var. adpressa Airy Shaw
S. reinwardtia Bl.

SAXIFRAGACEAE

Dichroa febrifuga Lour.

SIMAROUBIACEAE

Eurycoma longifolia Jack
Picrasma javanica Bl.

SOLANACEAE

Lycianthes biflora (Lour.) Coom.

SONNERATIACEAE

Duabanga moluccana Bl.

STAPHYLEACEAE

Erythroxylon cuneatum Kurz
Turpinia latifolia Hassk.
T. sphaerocarpa Hassk.

STERCULIACEAE

Firmiana malayana Kosterm.
Heritiera albiflora (Ridl.) Kosterm.
H. elata Ridl.
H. simplicifolia (Mast.) Kosterm.
Leptonychia heteroclita (Roxb.) Kurz
Pterospermum javanicum Jungh.
P. subpeltatum C.B. Rob.
Scaphium borneensis (Merr.) Kosterm.
Sterculia rubiginosa Vent.

Monogramma dareicarpa Hook.
Vaginularia trichoidea (J. Sm.) Fée
Pteris asperula J. Sm. agg.
P. clemensiae Copel.
P. ensiformis Burm.
P. excelsa Gaud.
P. furcans Baker
P. pellucida C. Presl
P. quadriaurita Retz.
P. scabripes Wall.
P. tripartita Sw.
P. vittata L.

HYMENOPHYLLACEAE

Microtrichomanes nitidulum (v.d. Bosch) Copel.
M. palmatifidum (K. Mueller) Copel.
Meringium acanthoides (v.d. Bosch) Copel.
M. bakeri (Copel.) Copel.
M. blandum (Racib.) Copel.
M. cardunculus (C.Chr. in Irmsch.) Copel.
M. denticulatum (Sw.) Copel.
M. holochilum (v.d. Bosch) Copel.
M. hosei (Copel.) Copel.
M. lobbii (Moore) Copel.
M. microchilum (Baker) ined.
M. pachydermicum (Ces.) Copel.
M. penangianum (Matthew & Christ) Copel.
Sphaerocionium pilosissimum (C.Chr) Copel.
Mecodium badium (Hook. & Grev.) Copel.
M. emarginatum (Sw.) Copel.
M. javanicum (Sprengel) Copel.
M. polyanthos (Sw.) Copel.
M. productum (Kze.) Copel.
M. salakense (Racib.) Copel.
M. thuidium (Harr.) Copel.
Trichomanes maximum Bl.
Crepidomanes bipunctatum (Poir.) Copel.
C. christii (Copel.) Copel.
C. kurzii (Bedd.) Tagawa & Iwatsuki
C. pervenulosum (v. Ald. v. Rosenb.) Copel.
C. sarawakense Iwats.
Reediella humilis (Forst.) Pichi Ser.
Pleuromanes album (Bl.) ined.
P. pallidum (Bl.) C. Presl
Gonocormus novoguineensis (Brause) Copel.
G. minutus (Bl.) v.d. Bosch
G. saxifragoides (C. Presl) v.d. Bosch
Selenodesmium obscurum (Bl.) Copel.
S. saxatile (Moore) ined.
Macroglena idonea (Morton) ined.
M. meifolia (Bory ex Willd.) Copel.
M. schlecteri (Brause) Copel.
M. setigera (Backh. ex Moore) ined.
Cephalomanes javanicum (Bl.) v.d. Bosch
C. laciniatum (Roxb.) de Vol
C. singaporeanum v.d. Bosch
C. sumatranum (v. Ald. v. Rosenb.) Copel.

OPHIOGLOSSACEAE

Helminthostachys zeylandica (L.) Hook.
Ophioglossum pendulum L.

MARATTIACEAE

Angiopteris evecta (Forst.) Hoffm.
A. subintegerrima v. Ald. v. Rosenb.
Marattia pellucida C. Presl
M. sylvatica Bl.
Macroglossum smithii (Racib.) Campbell
Christensenia aesculifolia (Bl.) Maxon

PLAGIOGYRIACEAE

Plagiogyra adnata (Bl.) Bedd.
P. tuberculata Copel.

SCHIZAEACEAE

Schizaea dichotoma (L.) Sm.
S. digitata (L.) Sw.
S. malaccana Baker
Lygodium borneense v. Ald. v. Rosenb.
L. circinnatum (Burm. f.) Sw.

PARKERIACEAE

Ceratopteris thalictroides (L.) Brongn.

ADIANTACEAE

Cheilanthes farinosa (Forsk.) Klf.
Pityogramma calomelanos Link
Syngramma alismifolia (C. Presl) J. Sm.
S. quinata (Hook.) Carr. in Seem.
Taenitis blechnoides (Willd.) Sw.
T. cordata (Gaud.) Holtt.
T. hookeri (C. Chr.) Holtt.
T. trilobata Holtt.
Adiantum hosei Baker
A. malesanium Ghatak
Antrophyum callifolium Bl.
A. parvulum Bl.
A. plicatum Bl.
A. reticulatum Klf.
A. semicostatum Bl.
A. subfalcatum Brack.
Vittaria angustifolia Bl.
V. elongata Sw.
V. ensiformis Sw.
V. longicoma Christ
V. scolopendrina (Bory) Thwait.

Nesopteris grandis (Copel.) Copel.
N. superba (Backh. ex Moore) Copel.
Microgonium mindorense (Christ) Copel.
M. motleyi v.d. Bosch
M. sublimbatum (K. Mueller) v.d. Bosch

GLEICHENIACEAE

Gleichenia brevipinnula Holtt.
G. bullata Moore
G. dicarpa R. Br.
G. hirta Bl. var. paleacea (Baker) C. Chr.
G. longissima Bl.
G. norrissii Bl.
G. truncata (Willd.) Spring
Dicranopteris linearis (Burm. f.) Underw. var. alternans (Mett.) Holtt.
D. linearis var. linearis
D. linearis var. ferruginea (Bl.) Holtt.
D. linearis var. montana Holtt.
D. linearis var. rigida (Bl.) Holtt.
D. speciosa (C. Presl) Holtt.

MATONIACEAE

Matonia pectinata R. Br.
Phanerosorus sarmentosus (Baker) Copel.

CHEIROPLEURIACEAE

Cheiropleuria bicuspis (Bl.) C. Presl

DIPTERIDACEAE

Dipteris conjugata Reinw.
D. lobbiana (Hook.) Moore
D. novoguineensis Posth.
D. quinquefurcata (Baker) Christ

POLYPODIACEAE

Drynaria sparsisora (Desv.) Moore
Merinthosorus drynarioides (Hook.) Copel.
Platycerium coronarium (Konig) Desv.
Pyrrosia angustata (Sw.) Ching
P. christii (Giesenh.) Ching
P. nummularifolia (Sw.) Ching
P. varia (Klf.) Farwell
Microsorum commutatum (Bl.) Copel.
M. heterocarpum (Bl.) Ching
M. musifolium (Bl.) Ching
M. nigrescens (Bl.) Copel.
M. punctatum (L.) Copel.
M. sarawakense (Baker) Holtt.
M. scolopendria (Burm. f.) Ching

Lecanopteris carnosa (Reinw.) Bl.
Colysis acuminata (Baker) Holtt.
C. bolsteri (Copel.) Copel.
C. macrophylla (Bl.) C. Presl.
C. membranacea (Bl.) C. Presl
Pycnoloma metacoelum (v. Ald. v. Rosenb.) C. Chr.
Holcosorus setaceus (Copel.) Copel.
Crypsinus albidopaleatus (Copel.) Copel.
C. albidosquamatus (Bl.) Copel.
C. enervis (Cav.) Copel.
C. platyphyllus (Sw.) Copel.
C. stenophyllus (Bl.) Holtt.
C. stenopteris (Baker) Parris
C. taeniatus (Sw.) Copel. var. borneensis (Christ) Tagawa
C. taeniatus var. taeniatus
C. trilobus (Houtt.) Copel.
Selliguea heterocarpa Bl.
S. lima (v. Ald. v. Rosenb.) Holtt.
S. treubii (Christ) Ching
Polypodiopteris brachypodia (Copel.) Reed
Lemnaphyllum accedens (Bl.) Donk
Paragramma longifolia (Bl.) Moore
Belvisia mucronata (Fée) Copel.
B. revoluta (Bl.) Copel.
Polypodium leucophorum Baker
Goniophlebion mehipitense (C. Chr.) Parris
G. rajaense (C.Chr.) Parris
G. subauriculatum (Bl.) C. Presl
Thylacopteris papillosa Kze.

GRAMMITIDACEAE

Grammitis bongoensis (Copel.) Copel.
G. friderici-et-pauli (Christ) Copel.
G. impressa Copel.
G jagoriana (Mett. ex Kuhn) Tagawa
G. knutsfordiana (Baker) Copel.
G. maxwellii (Baker) Parris
C. oblanceolata (Baker) Copel.
G. pilosiuscula Bl.
G. reinwardtii Bl.
G. reinwardtioides Copel.
G. setosa Bl.
G. sumatrana (Baker) Copel.
G. vittariifolia (C. Chr.) Parris
Xiphopteris alternidens (Ces.) Copel.
X. bryophylla (v. Ald. v. Rosenb.) Parris
X. hieronymusii (C. Chr.) Holtt.
Ctenopteris barathrophylla (Baker) Parris
C. brevivenosa (v. Ald. v. Rosenb.) Holtt.
C. brooksiae (v. Ald. v. Rosenb.) Parris
C. celebica (Bl.) Copel.
C. halconensis (Copel.) Copel.
C. mollicoma (Nees & Bl.) Kze.
C. moultoni (Copel.) Holtt.
C. nutans (Bl.) J. Sm.
C. subminuta (v. Ald. v. Rosenb.) Holtt.

Calymmodon conduplicatus (Brause) Copel.
C. cucullatus (Nees & Bl.) C. Presl
C. gracilis (Fée) Copel.
Acrosorus streptopyllus (Baker) Copel.
A. triangularis (Scort. ex Bedd.) Copel.
Prosaptia alata (Bl.) Christ
P. contigua (Forst.) C. Presl
Scleroglossum crassifolium (Baker) C. Chr.
S. minus (Fée) C. Chr. agg.
S. pusillum (Bl.) v. Ald. v. Rosenb.
Loxogramme antrophyoides (Baker) C. Chr.
L. forbesii Copel.
L. nidiformis C. Chr.
L. scolopendrioides (Gaud.) Morton

CYATHEACEAE

Cyathea assimilis Hook.
C. borneensis Copel.
C. glabra (Bl.) Copel.
C. latebrosa (Wall. ex Hook.) Copel.
C. leucotricha Christ
C. moluccana R. Br. ex Desv.
C. polypoda Baker
C. ramispina (Hook.) Copel.
C. recommutata Copel.
C. squamulata (Bl.) Copel.
C. wallacei (Mett. ex Kuhn) Copel.
Cystodium sorbifolium (Sm.) J. Sm.

THYRSOPTERIDACEAE

Cibotium barometz (L.) J. Sm.
C. cumingii Kze.

DENNSTAEDTIACEAE

Dennstaedtia glabrata (Ces.) C. Chr.
D. scabra (Wall. ex Hook.) Moore var. tenuisecta C. Chr.
D. smithii (Hook.) Moore
Microlepia manilensis (Goldm.) C. Presl ex Prantl
M. puberula v. Ald. v. Rosenb.
M. speluncae (L.) Moore var. villosissima C. Chr.
Pteridium caudatum (L.) Maxon subsp. yarrabense (Domin) Parris
Histopteris incisa (Thunb.) J. Sm.
H. stipulacea (Hook.) Copel.
Lindsaea borneensis Hook. ex Baker
L. bouillodii Christ
L. crispa Baker
L. divergens Hook. & Grev.
L. doryphora Kramer
L. integra Holtt.
L. lobata Poir.
L. lucida Bl. subsp. lucida
L. malayensis Holtt.

L. oblanceolata v. Ald. v. Rosenb.
L. obtusa J. Sm.
L. ovata J. Sm. in Hook.
L. parallelogramma v. Ald.v. Rosenb.
L. repens (Bory) Thwait. var. pectinata (Bl.) Mett. ex Kuhn
L. repens var. sessilis (Copel.) Kramer
L. rigida J. Sm. ex Hook.
L. sarawakense Kramer
L. walkerae Hook.
Sphenomeris chinesis (L.) Maxon
S. veitchii (Baker) C. Chr.
Tapeinidium luzonicum (Hook.) Kramer var. luzonicum
T. pinnatum (Cav.) C. Chr.
Xyropteris stortii (v. Ald. v. Rosenb.) Kramer

THELYPTERIDACEAE

Coryphopteris andersonii Holtt.
C. badia (v. Ald. v. Rosenb.) Holtt.
C. multisora (C. Chr.) Holtt.
C. viscosa (J. Sm.) Holtt. var. borneensis Holtt.
C. viscosa var. viscosa
Macrothelypteris torresiana (Gaud.) Holtt.
Pronephrium borneense (Hook.) Holtt. (ined.)
P. glandulosum (Bl.) Holtt.
P. hosei (Baker) Holtt.
P. menisciicarpon (Bl.) Holtt.
P. nitidum Holtt.
P. peltatum (v. Ald. v. Rosen.) Holtt. var. aberrans Holtt. (ined.)
P. peltatum var. persetiferum Holtt. (ined.)
P. salicifolium (Wall. ex Hook.) Holtt.
P. simillimum (C. Chr.) Holtt.
P. thysanoides Holtt. (ined.)
Mesophlebion beccarianum (Ces.) Holtt.
M. chlamydophorum (Rosenst.) Holtt.
M. crassifolium (Bl.) Holtt.
M. dulitense Holtt.
M. falcatilobum Holtt. (ined.)
M. falcatilobum Holtt. var. apiculatum Holtt. (ined.)
M. motleyanum (Hook.) Holtt.
M. trichopodum (C. Chr.) Holtt.
Plesioneuron medusella Holtt.
Chingia clavipilosa Holtt.
Sphaerostephanos baramensis (C. Chr.) Holtt. (ined.)
S. caulescens Holtt. (ined.)
S. heterocarpus (Bl.) Holtt. var. heterocarpus
S. heterocarpus var. borneensis Holtt. (ined.)
S. heterocarpus var. calcicola Holtt. (ined.)
S. hispidifolius (v. Ald. v. Rosenb.) Holtt.
S. inconspicuus (Copel.) Holtt.
S. latebrosus (Kze. ex Mett.) Holtt.
S. muluensis Holtt. (ined.)
S. perglanduliferus Holtt. (ined.)
S. porphyricola (Copel.) Holtt.
S. pterosporus (v. Ald. v. Rosenb.) Holtt. var. crenatus Holtt. (ined.)
S. reconditus Holtt. (ined.)
S. trichochlamys Holtt. (ined.)

Pneumatopteris brooksii (Copel.) Holtt.
P. callosa (Bl.) Nakai
P. eburnea Holtt. (ined.)
P. psilophylla Holtt. (ined.)
P. truncata (Poir.) Holtt.
Christella hispidula (Decr.) Holtt.
C. subpubescens (Bl.) Holtt.
Amphineuron immersum (Bl.) Holtt.
A. paraphysophorum (v. Ald. v. Rosenb.) Holtt.

ASPLENIACEAE

Asplenium affine Sw. var. affine
A. borneense Hook.
A. colubrinum Christ
A. dichotomum Hook.
A. macrophyllum Sw.
A. nidus L. var. nidus
A. pellucidum Lam.
A. phyllitidis L. subsp. malesicum Holtt.
A. pulcherrimum (Baker) Ching
A. salignum Bl.
A. scolopendrioides J. Sm.
A. tenerum Forst.
A. thunbergii Kze.
A. unilaterale Lam.
A. vittaeforme Cav.

DRYOPTERIDACEAE

Athyrium anisopterum Christ
Diplazium angustisquamatum (Holtt.) Parris
D. bantamense Bl.
D. cordifolium (Bl.) Copel.
D. crenatoserratum (Bl.) Moore
D. crinitum (Baker) C. Chr.
D. dilatatum Bl.
D. esculentum (Retz.) Sw.
D. falcinellum C. Chr.
D. hewittii (Copel.) C. Chr.
D. hottae Tagawa
D. latisquamatum Holtt.
D. malaccense C. Presl
D. maximum (Don) C. Chr.
D. megistophyllum (Copel.) Parris
D. moultoni (Copel.) Tagawa
D. pallidum (Bl.) Moore
D. pariens (Copel.) C. Chr.
D. poiense C. Chr.
D. polycarpum Copel.
D. porphyrorachis (Baker) Diels
D. riparium Holtt.
D. sorzogonense (C. Presl) Milde
D. speciosum Bl.
D. tomentosum Bl.
Cystopteris tenuisecta (Bl.) Mett.

Hypodematium crenatum (Forsk.) Kuhn
Ctenitis aciculata (Baker) Ching
Pleocnemia hemiteliiformis (Racib.) Holtt.
P. irregularis (C. Presl) Holtt.
P. olivacea (Copel.) Holtt.
Pteridrys acutissima Ching
P. microthecia (Fee) C. Chr. & Ching
Tectaria angulata (Willd.) C. Chr.
T. barberi (Hook.) Copel.
T. brooksii Copel.
T. crenata Cav.
T. devexa (Kze.) Copel.
T. holttumii C. Chr.
T. ingens (Atk.) Holtt.
T. labrusca (Hook.) Copel.
T. lobbii (Hook.) Copel.
T. maingayi (Baker) C. Chr.
T. melanorachis (Baker) Copel.
T. nitens Copel.
T. pleiosora (v. Ald. v. Rosenb.) C. Chr.
T. polymorpha (Wall.) Copel.
T. singaporiana (Wall.) Ching
T. ternata (Baker) Copel.
Heterogonium aspidiodes C. Presl
H. obscurum (Christ) Copel.
H. pinnatum (Copel.) Holtt.
H. sagenioides (Mett.) Holtt.
H. saxicolum (Bl.) Holtt.
Cyclopeltis cumingiana Fee
Polystichum lindsaeifolium Ridley
P. microphyllum (Bl.) C. Presl.
Arachniodes puncticulata (v. Ald. v. Rosenb.) Ching
A. tripinnata (Goldm.) Sledge
Dryopteris sparsa (Don) Kze
D. subarborea (Baker) C. Chr.
Acrophorus nodosus C. Presl

LOMARIOPSIDACEAE

Bolbitis appendiculata (Willd.) Iwats.
B. heteroclita (C. Presl) Ching
B. sinuata (C. Presl) Hennipman
B. virens (Hook. & Grev.) Schott
Teratophyllum aculeatum (Bl.) Mett. ex Kuhn
T. clemensiae Holtt.
Lomagramma brooksii Copel.
L. sinuata C. Chr.
Lomariopsis lineata (C. Presl) Holtt.
Elaphoglossum annamense C. Chr. & Tard.
E. blumeanum (Fée) J. Sm. var. blumeanum
E. heterolepium v. Ald. v. Rosenb.
E. melanostictum (Bl.) Moore
E. spongophyllum P.R. Bell
E. stenolepis Holtt.

DAVALLIACEAE

Humata heterophylla (Sm.) Desv.
H. pusilloides Copel.
H. repens (L. f.) Diels
H. subvestita (C. Chr.) Parris
H. vestita (Bl.) Moore
Davallia corniculata Moore
D. divaricata Bl.
D. lobbiana Moore
Davallodes borneense (Hook.) Copel.
D. burbidgei C. Chr.
Araiostegia hymenophylloides (Bl.) Copel.
Leucostegia immersa (Wall. ex Hook.) C. Presl var. amplissima Christ
L. immersa var. immersa
L. pallida (Mett. ex Kuhn) Copel.
Oleandra colubrina (Blanco) Copel.
O. coriacea Copel.
O. oblanceolata Copel.
O. pistillaris (Sw.) C. Chr.
O. sibbaldii Grev.
Nephrolepis biserrata (Sw.) Schott agg.
N. davallioides Kze.
N. falcata (Cav.) C. Chr.
N. hirsutula (Forst.) C. Presl

BLECHNACEAE

Blechnum borneense C. Chr.
B. finlaysonianum Wall.
B. orientale L.
B. vestitum (Bl.) Kuhn

Mammals recorded within Gunung Mulu National Park. Collated by the Earl of Cranbrook, June 1979; records from expedition Base Camp, Long Pala (outside Park boundary) are excluded.

The order of species follows Medway (1978) Mammals of Borneo, Monogr. Malaysian Branch Royal Asiatic Soc. No. 7

INSECTIVORA, the insectivores

Echinosorex gymnurus	Moonrat
Hylomys suillus	Lesser Gymnure
Suncus etruscus	Savi's Pigmy Shrew
Crocidura monticola	Sunda Shrew
Tupaia montana	Mountain Treeshrew
T. picta	Painted Treeshrew
Dendrogale melanura	Smooth-tailed Treeshrew

DERMOPTERA, the colugos

Cynocephalus variegatus	Flying Lemur

CHIROPTERA, the bats

Pteropus vampyrus	Flying Fox
Cyanopterus brachyotis	Malaysian Fruit Bat
Balionycteris maculata	Spotted-winged Fruit Bat
Aethalops alecto	Grey Fruit Bat
Penthetor lucasii	Dusky Fruit Bat
Rhinolophus borneensis	Borneo Horseshoe Bat
R. creaghi	Creagh's Horseshoe Bat
R. philippensis	Philippine Horseshoe Bat
Coelops robinsoni	Lesser Tailless Horseshoe Bat
Hipposideros galeritus	Cantor's Roundleaf Horseshoe Bat
H. insolens	Lyon's Roundleaf Horseshoe Bat
H. diadema	Diadem Roundleaf Horseshoe Bat
Myotis horsfieldii	Horsfield's Bat
Philetor brachypterus	Short-winged Brown Bat
Murina cyclotis	Round-eared Tube-nosed Bat
Tadarida plicata	Wrinkled-lipped Bat

PRIMATES, the monkeys, apes and relatives

Tarsius bancanus	Western Tarsier
Presbytis hosei	Grey Leaf Monkey
P. rubicunda	Maroon Leaf Monkey
P. cristata	Silvered Leaf Monkey
Macaca fascicularis	Long-tailed Macaque
M. nemestrina	Pig-tailed Macaque
Hylobates muelleri	Bornean Gibbon
Nycticebus coucang	Slow Loris

RODENTIA, the rodents

Ratufa affinis	Giant Squirrel
Callosciurus prevostii	Prevost's Squirrel
C. baluensis	Kinabalu Squirrel
C. notatus	Plantain Squirrel
Sundasciurus hippurus	Horse-tailed Squirrel
S. jentinki	Jentink's Squirrel
Lariscus insignis	Three-striped Ground Squirrel
Dremomys everetti	Bornean Mountain Ground Squir.
Exilisciurus exilis	Plain Pigmy Squirrel
E. whiteheadi	Whitehead's Pigmy Squirrel
Rheithrosciurus macrotis	Tufted Ground Squirrel
Aeromys tephromelas	Black Giant Flying Squirrel
Rattus muelleri	Müller's Rat
R. infraluteus	Mountain Giant Rat
R. cremoriventer	Dark-tailed Tree Rat
R. surifer	Red Spiny Rat
R. whiteheadi	Whitehead's Rat
R. rapit	Mountain Long-tailed Rat
R. Sabanus	Long-tailed Giant Rat
Chiropodomys gliroides	Tree-mouse (unidentified)
Trichys lipura	Long-tailed Porcupine
Hysterix/Thecurus	Large porcupines (not positively identified)

CARNIVORA, the carnivores

Helarctos malayanus	Sun Bear
Martes flavigula	Yellow-throated Marten
Lutra sp./Amblonyx	Otters (not positively ident.)
Viverra tangalunga	Malay Civet
Paradoxurus hermaphroditus	Common Palm Civet
Arctictis binturong	Bearcat
Arctogalidia trivirgata	Three-striped Palm Civet
Hemigalus derbyanus	Banded Palm Civet
Herpestes sp.	Mongoose

ARTIODACTYLA, the cloven-hoofed ungulates

Sus barbatus	Bearded Pig
Tragulus sp., cf. javanicus	(Lesser) Mouse-deer
Muntiacus muntjak	Barking Deer
Cervus unicolor	Sambhur

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67 species

Birds recorded within Gunung Mulu National Park, compiled by Lord Cranbrook; list dated June 1979. The order of species follows Smythies (1968), Birds of Borneo, 2nd edn. Oliver & Boyd, London.
Nomenclature has been updated to conform with present scientific conclusions.

PELECANIFORMES, the cormorants and allies

Anhinga melanogaster	Darter

ARDEIFORMES, the herons and storks

Butorides striatus	Little Green Heron
Goisakius melanolophus	Tiger Bittern
Ciconia stormi	Storm's Stork

FALCONIFORMES, the hawks and eagles

Macheiramphus alcinus	Bat Hawk
Pernis ptilorhyncus	Honey Buzzard
Haliastur indus	Brahminy Kite
Accipiter trivirgatus	Crested Goshawk
A. virgatus	Asiatic Sparrowhawk
Spizaetus alboniger	Blyth's Hawk Eagle
S. cf. nanus	(Wallace's) Hawk Eagle
Ictinaetus malayensis	Black Eagle
Icthyophaga humilis	Lesser Fish Eagle
Spilornis cheela	Crested Serpent Eagle
S. kinabaluensis	Kinabalu Serpent Eagle
Microhierax fringillarius	Black-thighed (Common) Falconet
Falco peregrinus	Peregrine Falcon

GALLIFORMES, the pheasants and partridges

Arborophila hyperythra	Red-breasted Tree Partridge
Melanoperdix nigra	Black Wood Partridge
Rollulus rouloul	Crested Green Wood Partridge
Haematortyx sanguiniceps	Crimson-headed Wood Partridge
Lophura erythrophthalma	Crestless Fireback Pheasant
L. ignita	Crested Fireback Pheasant
L. bulweri	Bulwer's Pheasant
Argusianus argus	Great Argus Pheasant

CHARADRIIFORMES, the gulls and waders

Actitis hypoleucos	Common Sandpiper

COLUMBIFORMES, the pigeons and doves

Treron capellei	Large Green Pigeon
T. curvirostra	Thick-billed Green Pigeon
Ptilinopus jambu	Jambu Fruit Pigeon
Ducula aenea	Green Imperial Pigeon
D. badia	Mountain Imperial Pigeon
Macropygia ruficeps	Little Cuckoo Dove
Chalcophaps indica	Emerald Dove

PSITTACIFORMES, the parrots

Loriculus galgulus	Malay Lorikeet

CUCLIFORMES, the cuckoos

Cuculus sparverioides	Large Hawk Cuckoo
C. fugax	Malayan Hawk Cuckoo
C. vagans	Moustached (Lesser) Hawk Cuckoo
C. micropterus	Indian Cuckoo
C. saturatus	Oriental Cuckoo
Cacomantis sonneratii	Banded Bay Cuckoo
C. variolosus	Fan-tailed Cuckoo
Surniculus lugubris	Drongo Cuckoo
Phaenicophaeus diardi	Lesser Green-billed Malcoha
P. chlorophaeus	Raffles' Malcoha
P. sumatranus	Rufous-bellied Malcoha
P. javanicus	Red-billed Malcoha
P. curvirostris	Chestnut-breasted Malcoha
Centropus sinensis	Common Coucal
C. rectunguis	Short-toed Coucal
Carpococcyx radiceus	Ground Cuckoo

STRIGIFORMES, the owls

Phodilus badius	Bay Owl
Otus rufescens	Reddish Scops Owl
O. spilocephalus	Mountain Scops Owl
O. ? brookei	(Rajah's) Scops Owl
Glaucidium brodiei	Pigmy Owlet
Ninox scutulata	Hawk Owl
Strix leptogrammica	Malaysian Wood Owl

CAPRIMULGIFORMES, the nighjars and allies

Batrachostomus auritus	Large Frogmouth
B. sp.	Frogmouth

APODIFORMES, the swifts

Aerodramus	vanikorensis	Mossy-nest Swiftlet
A.	fuciphagus	Edible-nest Swiftlet
Collocalia	esculenta	White-bellied Swiftlet
Rhaphidura	leucopygialis	White-rumped Spine-tail Swift
Hirundapus	giganteus	Malaysian Spine-tailed Swift
Hemiprocne	longipennis	Crested Tree-swift
H.	comata	White-whiskered Tree-swift

TROGONIFORMES, the trogons

Harpactes	diardi	Diard's Trogon
H.	kasumba	Red-naped Trogon
H.	whiteheadi	Whitehead's Trogon
H.	duvauceli	Scarlet-rumped Trogon
H.	orrhophaeus	Cinnamon-rumped Trogon
H.	oresdias	Orange-breasted Trogon

CORACIIFORMES, the rollers and allies

Lacedo	pulchella	Banded Kingfisher
Halcyon	concreta	Chestnut-collared Kingfisher
H.	pileata	Black-capped Kingfisher
Pelargopsis	capensis	Stork-billed Kingfisher
Alcedo	meninting	Deep Blue Kingfisher
A.	euroyzona	Blue-banded Kingfisher
Ceyx	erithacus (rufidorsus)	Forest Kingfisher
Nyctyotnis	amictus	Red-bearded Bee-eater
Berenicornis	comatus	White-crested Hornbill
Anorrhinus	galeritus	Bushy-crested Hornbill
Rhyticeros	corrugatus	Wrinkled Hornbill
R.	undulatus	Wreathed Hornbill
Anthracoceros	malayanus	Black Hornbill
A.	coronatus	Pied Hornbill
Buceros	rhinoceros	Rhinoceros Hornbill
Rhinoplax	vigil	Helmet Hornbill

PICIFORMES, the woodpeckers and allies

Calorhamphus	fuliginosus	Brown Barbet
Megalaima	chrysopogon	Gold-wiskered Barbet
M.	rafflesi	Many-colored Barbet
M.	mystacophanos	Gaudy Barbet
M.	henricii	Yellow-crowned Barbet
M.	pulcherrima	Golden-naped Barbet
M.	monticola	Mountain Barbet
M.	eximia	Black-throated Barbet
M.	australis	Little Barbet
Sasia	abnormis	Rufous Piculet
Picus	puniceus	Crimson-winged Woodpecker
P.	mentalis	Checker-throated Woodpecker
P.	miniaceus	Banded Red Woodpecker
Celeus	brachyurus	Rufous Woodpecker

Meiglyptes tristis	Fulvous-rumped Barred Woodpecker
M. tukki	Buff-necked Barred Woodpecker
Hemicircus concretus	Grey & Buff Woodpecker
Dinopium rafflesi	Olive-backed Three-toed Woodpecker
Muelleripicus pulverulentus	Great Slaty Woodpecker
Blythipicus rubiginosus	Maroon Woodpecker
Rheinwardtipicus validus	Orange-backed Woodpecker

PASSERES, the passerine birds

Calyptomena viridis	Green Broadbill
C. hosei	Hose's Broadbill
C. whiteheadi	Whitehead's Broadbill
Psarisomus dalhousiae	Long-tailed Broadbill
Cymbirhynchus macrorhynchos	Black and Red Broadbill
Eurylaimus ochromalus	Black and Yellow Broadbill
E. javanicus	Banded Broadbill
Corydon sumatranus	Dusky Broadbill
Pitta arcuata	Blue-banded Pitta
P. granatina	Garnet Pitta
P. baudi	Blue-headed Pitta
Hirundo tahitica	Pacific Swallow
H. rustica	Barn Swallow
Motacilla caspica	Grey Wagtail
M. flava	Yellow Wagtail
Tephrodornis gularis	Hook-billed Grebird
Coracina larvata	Black-faces Greybird
C. fimbriata	Lesser Greybird
Hemipus hirundinaceus	Black-winged Flycatcher-Strike
H. picatus	Bar-winged Flycatcher Strike
Chlamydochaera jeffreyi	Black-breasted Triller
Pericrocotus solaris	Mountain Minivet
P. flammeus	Scarlet Minivet
Aegithina viridissima	Green Iora
Chloropsis cyanopogon	Lesser Green Leafbird
C. sonnerati	Greater Green Leafbird
C. cochinchinensis	Blue-winged Leafbird
Irena puella	Fairy Bluebird
Pycnonotus eutilotus	Crested Brown Bulbul
P. melanoleucos	Black and White Bulbul
P. atriceps	Black-headed Bulbul
P. squamatus	Scaly-breasted Bulbul
P. cyaniventris	Grey-bellied Bulbul
P. zeylanicus	Yellow-crowned Bulbul
P. flavescens	Pale-faced Bulbul
P. plumosus	Large Olive Bulbul
P. brunneus	Red-eyed Brown Bulbul
P. simplex	Cream-vented (White-eyed) Brown Bulbul
P. erythropthalmus	Lesser Brown Bulbul
Criniger bres	Scrub (Olive White-throated) Bulbul
C. ochraceus	Brown White-throated Bulbul
C. phaeocephalus	Crestless White-throated Bulbul
C. finschii	Finsch's Bulbul

Setornis criniger	Hook-billed Bulbul
Hypsipetes criniger	Hairy-backed Bulbul
H. malaccensis	Streaked Bulbul
H. charlottae	Crested Olive Bulbul
H. flavala	Ashy Bulbul
Erithacus cyane	Siberian Blue Robin
Brachypteryx montana	Blue Shortwing
Copsychus pyrropyga	Orange-tailed Shama
C. saularis	Magpie Robin
C. malabaricus	White-rumped Shama
Enicurus leschenaulti	White-crowned Forktail
E. ruficapillus	Chestnut-naped Forktail
Zoothera everetii	Everett's Ground Thrush
Myophoneus glaucinus	Sunda Whistling Thrush
Eupetes macrocerus	Rail Babbler
Pellorneum capistratum	Black-capped Jungle Babbler
Trichastoma pyrrhogenys	Temmick's Jungle Babbler
T. malaccense	Short-tailed Jungle Babbler
T. rostratum	Blyth's Jungle Babbler
T. bicolor	Ferruginous Jungle Babbler
T. sepiarium	Horsfield's Jungle Babbler
Malacopteron magnum	Greater Red-headed Tree Babbler
M. cinereum	Lesser Red-headed Tree Babbler
M. magnirostre	Moustached Babbler
M. albogulare	White-throated Babbler
Pomatorhinus montanus	Chestnut-backed Scimitar Babbler
Ptilocichla leucogrammica	Bornean Wren Babbler
Kenopia striata	Striped Wren Babbler
Napothera atrigularis	Black-throated Wren Babbler
N. crassa	Mountain Wren Babbler
N. epilepidota	Small Wren Babbler
Macronus ptilosus	Fluffy-backed Tit Babbler
Stachyris nigriceps	Grey-throated Tree Babbler
S. poliocephala	Grey-headed Tree Babbler
S. nigricollis	Black-necked Tree Babbler
S. leucotis	White-necked Tree Babbler
S. maculata	Red-rumped Tree Babbler
S. erythroptera	Red-winged Tree Babbler
S. rufifrons	Hume's Tree Babbler
Garrulax lugubris	Black Laughing Thrush
G. palliatus	Grey & Brown Laughing Thrush
G. mitratus	Chestnut-capped Laughing Thrush
Pteruthius flaviscapis	Red-winged Shrike Babbler
Alcippe brunneicauda	Brown Quaker Babbler
Minla castaneiceps	Chestnut-headed Minla
Yuhina zantholeuca	White-bellied Yuhina
Gerygone sulphurea	Flyeater
Cettia whiteheadi	Short-tailed Bush Warbler
C. fortipes	Mountain Bush Warbler
Phylloscopus borealis	Arctic Leaf Warbler
P. trivirgatus	Mountain Leaf Warbler
Seicercus montis	Yellow-breasted Flycatcher Warbler
Abroscopus superciliaris	White-throated Flycatcher Warbler
Orthotomus cuculatus	Mountain Tailorbird
O. ruficeps	Ashy (Red-headed) Tailorbird

Rhipidura albicollis	White-throated Fantail F.
R. perlata	Spotted Fantail Flycatcher
R. javanica	Pied Fantail Flycathcher
Culicicapa ceylonensis	Grey-headed Flycathcher
Muscicapa sibirica	Sooty Flycatcher
M. latirostris	Brown Flycatcher
M. indigo	Indigo Flycatcher
Cyanoptila cyanomelana	Blue and White Flycatcher
Cyornis concreta	White-tailed Blue Flycatcher
C. unicolor	Pale Blue Flycatcher
C. turcosa	Malaysian Blue Flycatcher
C. caerulata	Large-billed Blue Flycatcher
C. banyumas	Hill Blue Flycatcher
C. superba	Bornean Blue Flycatcher
Ficedula hyperythra	White-fronted Blue Flycatcher
F. dumetoria	Orange-breasted Flycatcher
F. westermanni	Little Pied Flycatcher
Muscicapella hodgsoni	Pigmy Blue Flycatcher
Rhinomyias umbratilis	White-throated Jungle F.
R. ruficauda	Rufous-tailed Jungle Flycatcher
R. gularis	White-browed Jungle Flycatcher
Philentoma pyrhoterum	Chestnut-winged Monarch F.
P. velatum	Maroon-breasted Monarch F.
Hypothymis azurea	Black-naped Blue Monarch Flycatcher
Terpsiphone paradisi	Paradise Flycatcher
Pachycephala hypoxantha	Bornean Mountain Whistler
Sitta frontalis	Velvet-fronted Nuthatch
Prionochilus thoracicus	Scarlet-breasted Flowerpecker
P. xanthopygius	Yellow-rumped Flowerpecker
P. maculatus	Yellow-throated Flowerpecker
Dicaeum chrysorrheum	Yellow-vented Flowerpecker
D. monticola	Black-sided Flowerpecker
Anthreptes simplex	Pain-coloured Sunbird
A. rhodolaema	Rufous-throated Sunbird
A. singalensis	Ruby-cheeked Sunbird
Hypogramma hypogrammicum	Purple-naped Sunbird
Aethopyga siparaja	Yellow-backed Sunbird
A. mystacalis	Scarlet Sunbird
Arachnothera longirostra	Little Spiderhunter
A. robusta	Long-billed Spiderhunter
A. affinis	Grey-breasted Spiderhunter
A. juliae	Whitehead's Spiderhunter
Zosterops atricapilla	Black-capped White-eye
Chlorocharis emiliae	Mountain Blackeye
Gracula religiosa	Grackle or Talking Myna
Erythrura hyperythra	Bamboo Munia
Dicrurus annectans	Crow-billed Drongo
D. leucophaeus	Grey Drongo
D. hottentottus	Hair-crested Drongo
D. paradiseus	Large Racket-tailed Drongo
Oriolus xanthonotus	Black-headed Oriole
O. cruentus	Black and Crimson Oriole
Platylophus galericulatus	Crested Jay
Dendrocitta occipitalis	Malaysian Treepie
Crovus enca	Slender-billed Crow

262 species

A preliminary list of fish recorded within Gunung Mulu National Park, compiled by Joan Cramphorn.

BAGRIDAE

Mystus baramensis

COBITIDAE

Acanthopthalmus sp.
Noemacheilus fasciatus

CYPRINIDAE

Barbus binotatus
B. bramoides
B. bulu
B. collingwoodi
B. douronensis
B. tambroides
Cyclocheilichthys apogon
C. repasson
Garra borneensis
Hampala bimaculata
Labeo pleurotaenia
Leptobarbus hosii
Lobocheilus bo
Luciosoma setigerum
Nematabramis everetti borneensis
Osteochilus hasselti
O. kahajanensis
O. microcephalus
O. vittatus
Oxygaster anomalura
Paracrossocheilus acerus
Rasbora argyrotaenia
R. dusonensis
R. sumatranus
R. volzi

GOBIIDAE

Unidentified species

HEMIRHAMPHIDAE

Hemirhamphodon pogonognathus

HOMALOPTERIDAE

Gastromyzon borneensis
G. nieuwenhuisi
Gastromyzon sp. nov.
Homaloptera orthogoniata
H. wassinki
H. webberi
Homaloptera sp.
Parahomaloptera microstoma

MASTACEMBELIDAE

Mastacembelus armatus
M. maculatus
M. unicolor

OPHICEPHALIDAE

Ophicephalus striatus

OSPHRONEMIDAE

Osphronemus goramy

SCHILBEIDAE

Pangasius dezwanii

SILURIDAE

Kryptopterus sp.

SISORIDAE

Glyptothorax major

SYNGNATHIDAE

Dorichthys deokhatoides

47 species

Butterflies recorded within Gunung Mulu National Park

Compiled by J.D.Holloway, July 1979

PAPILIONIDAE

Trogonoptera brookiana
Troides amphrysus
Atrophaneura nox
A. neptunus
Pachliopta aristolochiae
Chilasa paradoxa
C. slateri
Papilio demolion
P. nephelus
P. helenus
P. fuscus
P. memnon
P. karna
Graphium sarpedon
G. evemon
G. bathycles
G. doson
G. eurypylus
G. agamemnon
G. empedovana
Pathysa antiphates
P. agetes
P. stratiotes
Paranticopsis delesserti
P. macareus
P. ramaceus
Meandrusa payeni
Lamproptera curius
L. meges

PIERIDAE

Delias ninus
D. georgina
D. henningia
D. eumolpe
D. hyparete
Leptosia nina
Prioneris cornelia
P. philonome
Cepora iudith
C. pactolicus
Appias lyncida
A. nero
A. paulina
A. indra
A. cardena
Saletara liberia
Ixias pyrene
Hebomoia glaucippe
Pareronia valeria
Dercas verhuelli
Catopsilia pyranthe
C. pomona
Eurema blanda
E. simulatrix
E. ada
E. hecabe
E. sari
E. andersonii
E. lacteola
E. tilaha
E. tominia
Gandaca harina

DANAIDAE

Parantica crowleyi
P. aspasia
P. agleoides
Radena vulgaris
Ideopsis gaura

Idea hypermnestra
I. iasonia
Euploea camaralzeman
E. crameri
E. eyndhovii
E. algea
E. mulciber
E. modesta
E. leucostictos
E. diocletianus

SATYRIDAE

Melanitis leda
Elymnias kuenstleri
E. penanga
E. esaca
Lethe perimede
Ptychandra talboti
Neorina lowii

The order of species follows Corbet & Pendlebury (1978) ed.3 by J.N.Eliot, Malayan Nature Soc., Kuala Lumpur.

SATYRIDAE (Continued)

Mycalesis anapita
M. orseis
M. maianeas
Orsotriaena medus
Erites argentina
Coelites euptychioides
Ragadia makuta
Ypthima pandocus
Y. baldus
Y. fasciata
Ypthima nov. sp.

AMATHUSIINAE

Faunis canens
F. kirata
F. gracilis
F. stomphax
Taenaris horsfieldii
Xanthotaenia busiris
Amathusia sp.
Thaumantis odana
T. klugius
Discophora necho

NYMPHALIDAE

Ariadne isaeus
Laringa castelnaui
Cupha erymanthis
Phalanta alcippe
Vagrans egista
Vindula erota
V. dejone
Cirrochroa emalea
C. malaya
C. tyche
C. satellita
Terinos clarissa
Cethosia hypsea
Precis atlites
Kaniska canace
Symbrenthia anna
Rhinopalpa polynice
Hypolimnas anomala
Doleschallia bisaltide
Kallima paralekta
Cyrestis nivea
C. theresae
Chersonesia peraka
C. intermedia
C. rahria
C. risa
Neptis duryodana
N. nata
N. leucoporos
N. hylas
Lasippa montana
L. heliodore
Pantoporia aurelia
P. paraka
P. hordonia
Athyma larymna
A. pravara
A. reta
A. abiasa
A. nefte
A. gynea
Pandita sinope
Moduza procris
Lebadea martha
Parthenos sylvia
Tanaecia pelea
T. munda
T. aruna
T. amisa
T. iapis
T. godartii
Euthalia monina
E. whiteheadi
Bassarona dunya
Lexias dirtea
L. canescens
Amnosia decora
Dichorragia nesimachus
Eulaceura osteria
Euripus nyctelius
Prothoe franck
Agatasa calydonia
Polyura athamas
P. jalysus
P. moori
P. delphis
P. schreiber
Charaxes bernardus
C. borneensis
C. solon

RIODINIDAE

Dodona elvira
Abisara savitri
A. geza
A. kausambi

Paralaxita orphna
Laxita teneta

LYCAENIDAE

Miletus heracleion
M. zinckenii
M. gopara
M. gaetulus

LYCAENIDAE (Continued)

Allotinus macassariensis
A. strigatus
A. substrigosa
Logania regina
Discolampa ethion
Caleta elna
Lycaenopsis haraldus
Celastrina puspa
C. cossaea
C. dilecta
C. musina
C. limbata
C. selma
C. camenae
C. shelfordii
Celastrina sp. near lingga
Neopithecops zalmora
Catachrysops panormus
Jamides pura
J. zebra
J. elpis
J. cunilda
J. abdul
J. talinga
J. limes
J. cyta
J. lugine
J. alecto
J. bochus
Nacaduba kurava
N beroe
Ionolyce helicon
Prosotas aluta
P. nora
P. pia
Una usta
Anthene lycaenina
A. emolus
Austrozephyrus borneanus
Arhopala aedias
A. epimuta
A. kinabala
A. catori
A. muta
A. antimuta
A. agesilaus
A. democritus
A. aroa
A. azinis
A. denta
A. paraganesa
A. ariel
Surendra florimel
Amblypodia narada
Eooxylides tharis
Cheritra freja
Drupadia ravindra
D. theda
D. cineas
Dacalana lowii
Britomartis nov. sp.
Neocheritra amrita
Remelana jangala
Hypolycaena erylus
Zeltus amasa
Rapala manea
Curetis tagalica

HESPERIIDAE

Bibasis harisa
B. etelka
B. sena
Hasora quadripunctata
H. vitta
H. schoenherr
H. borneensis
H. mus
Badamia exclamationis
Charmion ficulnea
C. ladena
Tagiades lavata
T. waterstradti
T. ultra
Odontoptilum pygela
Halpe sikkima
Iambrix obliquans
I. stellifer
Koruthaialos rubecula
K. focula
Psolos fuligo
Ancistroides nigrita
A. armatus
A. gemmifer
Notocrypta paralysos
Erionota thrax
Unkana ambasa
U. mytheca
Oriens gola
Pelopidas conjuncta

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281 species

Recommendation made by the Sarawak Government Ethnologist (in Kedit,P 1978. Sarawak Mus. Fld. Rep I:39-42).

"II. These recommendations are submitted for considerations of the planners for the proposed Master Plan for the Gunong Mulu National Park, as well as, where applicable, for the general administrators whose task is to secure the better wellbeing of the Penan and other minority groups in Sarawak.

II.I <u>Penan's role in the Park's development</u>: It should be categorically stated in the Master Plan the roles the Penan have to play in the National Park. There should be regulations protecting their interests and ample opportunities given to them to be usefully employed. They can be gainfully employed as forest guards; guides for tourist or youth campers; informants or instructors, should there be a scientific research station established in the Park area or, the setting up of a National Park School. In dividing the Park into restricted zones for mass visitors, the Penan should be given access to restricted areas and be regarded as part of the ecosystems. The area that would be least frequented by visitors can be reserved for the traditional Penan to live their indigenous ways (See <u>Map I</u>, Zones 'B' and 'D' are applicable).

II.2 <u>Penan Reserves/Settlement Area</u>: Penan Reserves or settlement areas should be constituted immediately outside the Park's buffer zones towards the Brunei border (See <u>Map II</u> for the proposed settlement site). At present these areas are under timber concession but when they are free from logging activities, they could be reserved for Penan settlement. According to the draft soils survey report of this area conducted by the Agriculture Department, some parts of these lands can be utilized for agriculture (e.g. padi planting). However, further detailed survey may be required. This part of the area, between Sungei Besanan and Sungei Lutut, would also be the likely route to be taken by the proposed Miri/Limbang Road. In the event that this is so, then that stretch of land should be protected for the Penan by legal sanction.

II.3 <u>Agricultural Training and Extension Service</u>: Before settling the Penan, sufficient number of them should be given agricultural training. This can be in the form of the usual farmers training provided by the Agriculture Department, or the attachment of field officers on their settlement site to teach them. Both males and females should be given equal emphasis in training. In extension service, first attention should be given to the planting of food crops (even sago) and animal husbandry, rather than cash crops.

II.9 Department of Ethnic Minorities: It is for the long-term interests of not only the Penan/Punan, but also of other minority ethnics in Sarawak that a specifically instituted authority to look after their affairs, and to protect their legal rights be established. This has been done in Peninsular Malaysia for the Orang Asli in the form of the Jabatan Orang Asli; and also there is the example in the Philippines of the Presidential Arm for National Minorities (Panamin), which looks after the interest of minority groups in their country. Sarawak have some similar cases that can benefit with such attention devoted to them. The advantages of a separate department are that it comes under a Ministry, with a Minister responsible to it, and it has its own funds and personnel running its affairs. As it is, even though the Penan are served by various departments their efforts are diffused, and no one department is specifically responsible to the Penan (a community, who by their very nature need special attention). So there is much to be said for establishing a separate department for the Penan; and in this case, a department like this can initiate a pilot to resettle the Penan at Gunong Mulu National Park area with the Penan Community Development Task Force spearheading its first programme.

II.IO Statement of Policy: Finally, enough has been said by many on the Penan/Punan as appeared in the press and elsewhere by various official and unofficial sources. There is now no place for romanticism nor excuse for ignorance. Where the Penan people are concerned they are at the receiving end of something which were not of their doings, or even their understanding. Hence, it is in my sober and considered opinion that a statement of policy from the appropriate authority on the Penan/Punan would be most welcomed by those who have some regard for the wellbeing of the Penan/Punan, as well as, by the people concerned.

When in 196I, the newly independent Malayan government wished to state their policy on the Orang Asli, they published an important document entitled: "Statement of Policy regarding the Administr.tion of the Aborigine Peoples of the Federation of Malaya." This document begins by saying that, 'the aborigines, being one of the ethnic minorities of the Federation must be allowed to benefit on an equal footing from the rights and opportunit.es which the law grants to the other sections of the community'. (See Carey, I, 1976. Orang Asli: The Aboriginal Tribes of Peninsular Malaysia, 294 et sequ.). Oxford University Press, Kuala Lumpur.

We should well consider the propriety of such approach."

2I.XII.78 P.M.K.

Tentative list of wild plants used by the Penan for medicinal purposes, (After Kedit, 1978 p. 64-65).

Penan names	Function	Application
Panawan Laba	For cough	Chew stem
Sabalui pu-an	For upset stomach and cough	Chew young shoots or the vines
Bhut	Anti-dote for poison dart	Crush and rub bark on the wound
Sekaliu	To make dart poison	Pound and mix required amount of leaf and latex
Kalakek	For stomachache/ Diarrhoea	Crush root, boil and drink water
Duhaw	For cough, stomach-ache, headache, also: anti-dote for poison dart	Chew raw bark Boil and rub leaf on the wound
Kelalai	For cough	Chew young leaves
Eput	For bone dislocation	Pound root, and wrap on the affected part
Tubo	Headache	Crush stalk and bandage on the head
	Insect bite	Crush stalk and rub on the bite
Sala Tulang	Rheumatism	Pound leaves and twine, wrap around the affected part
Laka Daha	Toothache	Take red latex and apply
Tengalai	Backache	Crush leaf, bandage on the affected part
Long Tapik	Stomachache/ Toothache	Crush shoot, dip in hot water, and eat
	Cure poison dart	Rub bark against the wound
Posong	Itchy skin	Crush bark and apply
Kayu Batern	To cure dog	Burn wood and give charcoal to eat
Cha-pulu-an	Anti-dote for alcohol	Chew the bark and woody part

Laka parat	Fever	Crush leaves, mix with water and drink
Penawat Prahak	Stomachache/cough	Chew the bark
Sapungan	For curing poison dart	Pound bark and rub on the part
Gatimang	For curing poison dart	Pound bark and rub on the part
Selah Pelihai	To cure swollen body	Heat leaf and rub on the affected part
Penawat	Stomachache/cough	Chew the bark
Sabulu Pugan	Stomachache/cough	Chew the bark
Kayu Chalah Pelihai	To cure swollen body	Heat leaf and rub on the affected part
Nyakup	Headache	Pound bark, dip in water and bandage on the head
Penawat Le-bak	Cough	Eat raw shoot
Tapakaq Sa-iy	Stomachache	Pound bark, dip in water and drink
Chala Busang	Nose bleeding and vomiting blood	Chew leaf
Getimang	Stomachache	Crush bark, dip in water and drink
Muyah	Cure baby's stomachache	Boil leaves and rub liquid on baby's stomach
Tohboh Pesong	Ringworm	Crush stalk, leaves and rub
Jelah Payau	To improve children's appetite	Boil leaf, drink liquid
Penawat Ube	Anit-dote for alcohol and food poisoning	Chew bark
Lakah Dahaq	Toothache	Apply the latex
Kalalai	For cough	Crush leaves, drink liquid
Sabului Pugam	Anti-dote for alcohol Toothache	Chew bark and root Apply latex
Penawat Harag	Anti-dote for alcohol Toothache	Chew bark and root Apply latex
Eko Kuyat	For cough	Chew the root
Itap	For cuts	Burn the root and apply ash to wound

Wild plants used by Penan for domestic use, (After Kedit, 1978, p. 66).

Penan names	Function	Application
Nyangang Putut	Blowpipe making	Cut wood into shape and bore the hole
Beruwah	For sago processing	Sapling arranged as structures
Temaha	For sago processing	Cut wood into shape
Laka Daha	Rope fibre	Twine the woody vine
Karot	For sago processing	Hard wood could be used for house structure or sago tools also blowpipe
Itot	Roofing material, mat and wrapper	Sewn leaves together
Sebangat	For dyeing rottan	Boil leaves, rottan dip in the water.
Kelalai	Blowpipe making	Cut wood into shape and bore the hole
Dal	For walling materials	Bark taken tie to walling frame
Tulio Sibu	For detergent	Rub the leaves against the skin to produce a foam
Long	To make ipoh (latex) poison more potent	Pound leaves mix into latex
Tobok	Roofing material	Sewn leaves together
Ba-aq ta-o	For making boats	Cut into required shape
Pabakun	Collect latex for sale	Boil and left to coagulate
Laka Bakala	Used as "sand paper"	Leaves rub against the required wood material
Sapungan	For parang's hilt	Cut into required shape
Kemitan	For making string	Take the fibres of the bark and then twine together to make a string
Makan	Bird's "gum"	Boil the latex and apply to the stick and place at required place

Daun	Roofing material also for mat and hat	Sew leaves together
Kerumat	Hut material	Wood built into required structure
Kalatang	Container	Bark made into required shape
Bakuyag	Chopsticks for eating sago	Fashioned into required shape
Tapukang Matan	For firewood	Cut and split
Pawn	For making sape musical instruments	Fashioned into required shape
Tobog	For roofing materials	Leaves are sewn together to a frame
Madang	For roofing material and bark cloth	Leaves are sewn together to a frame for roof Bark strip off and beaten with bark beater to make bark cloth

Tentative list of wild plants used by the Penan for food, (After Kedit, 1978, p. 67).

Penan names	Uses	Preparation
Toboq buang	Fruit	Taken raw
Deri	Fruit	Taken raw
Sawit Pedun (rottan vines)	Fruit	Taken raw
Buah Nyakob	Nut	Taken raw
Karot (tree)	Fruit	Taken raw
Buah Tikalat (tree)	Fruit	Taken raw
Sebangat (tree)	Fruit	Taken raw
Sabat (creeper)	Fruit	Taken raw
Segela (palm)	Fruit	Taken raw
Kelalai (tree)	Fruit	Taken raw
Kohot (rottan)	Shoot	Cook
Posong (tree)	Fruit	Taken raw
Malawak (tree)	Fruit	Taken raw
Buah Diran	Fruit	Taken raw
Beripun	Fruit	Taken raw
Balawag	Fruit	Taken raw
Laka Bakala (vine)	Water inside vine drinkable	Taken raw
Buah Pulutan (tree)	Fruit	Taken raw
Malasau (tree)	Fruit	Taken raw
Makan	Fruit	Taken raw
Kusap	Fruit	Taken raw
Matatu dau	Fruit	Taken raw
Guhupun	Fruit	Taken raw
Tartar	Fruit and shoot	Taken raw and cook
Madang	Fruit	Taken raw
Butre	Fruit	Taken raw
Melasik	Fruit	Taken raw
Sebert	Fruit	Taken raw
Buah vayan	Fruit	Taken raw

Uhum Kuwai	Fruit	Taken raw
Nyagang	Fruit	Taken raw
Malawag	Fruit	Taken raw
Laka palustu	Fruit	Taken raw
Guhpum	Fruit	Taken raw
Basalaky	Fruit	Taken raw
Pahei	Fruit	Taken raw
Laka Sabat	Fruit	Taken raw
Jek	Fruit	Taken ripe
Pongung	Wild rambutan	Taken ripe
Alim	Fruit	Taken ripe and raw
Mohak	Fruit	Taken raw
Duyan	Wild durian	Taken ripe
Tungan	Fruit	Taken raw
Mesilat	Fruit	Taken raw
Meteh	Fruit	Taken raw
Pan Busing	Fruit	Taken raw
Baliat	Fruit	Taken raw
Jaman	Fruit	Taken raw
Buah Akit	Fruit	Taken raw
Buah Kamatak	Fruit	Taken raw
Tugurak	Fruit	Taken raw

Tentative list of wild plants used by the Penan for rituals (After Kedit, 1978, p. 68).

Penan names	Uses	Application
Daun Long (taro-type plant)	To stop baby from crying	Burn root and place it on the stomach
Nyet	To make dog good in hunting	Pound and soak the bark and pour into the nostril
Kayu Kapuk	To dispel evil spirit and to prevent strong wind and storm	Burn the leaf to give away scent
Kamalut (creeper)	Taboo	Cannot build hut near it, should not pass in the morning or evening as the evil spirits abode in it; permissible when the sun is overhead - evil spirit then have left the tree
Long (grass type)	To dispel evil spirit	Tie the plant below the infant's sleeping place
Kerijut	To make dog active	Pound bark and rub against the nostrils
Bok (creeper)	To stop baby crying	Burn root, charcoal rubbed on forehead

Provided that no person shall be arrested or detained without warrant unless reasonable grounds exist for believing that, except by the arrest of such person, he could not be found or made answerable to justice without undue delay, trouble or expense.

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*Modified by Swt. L.N. 68 of 1964.

Section 14 of the National Parks Ordinance (Chapter 127)
Dated 16th February 1956.

CONTROL OF NATIONAL PARKS.

Restriction on certain acts in a national park.

14. No person, other than a person acting under and in accordance with the permission of the Trustees, shall—

(*a*) convey into a national park, or, within the confines thereof, be in possession of, any weapon, explosive, trap or poison;

(*b*) within a national park, kill, injure, capture or disturb any animal or take or destroy any egg or nest;

(*c*) cut or set fire to any vegetation or damage any object of geological, prehistoric, archaeological, historical or other scientific interest in a national park;

(*d*) introduce any animal, or permit any domestic animal to stray, into a national park, or introduce any vegetation into a national park;

(*e*) remove from a national park any animal or vegetation, whether alive or dead, other than any animal or vegetation lawfully introduced into a national park by the person removing it;

(*f*) remove from a national park any object of geological, prehistoric, archaeological, historical or other scientific interest;

(*g*) destroy or deface any object, whether animate or inanimate, in a national park;

(*h*) erect any building in a national park;

(*i*) clear or break up any land in a national park; or

(*j*) without prejudice to any rights lawfully acquired before the 16th day of February, 1956, and to the provisions of any law for the time being in force in Sarawak relating to mining, prospect for or mine minerals in any national park.

Power of arrest, search and seizure.

15. Any police officer may arrest without warrant any person who commits any offence against this Ordinance or any regulations made hereunder, and any Park Warden or Park Ranger, authorized thereto in writing by the *Conservator of Forests, may arrest without warrant any person reasonably suspected of committing any such offence, and may detain such person until he can be delivered into the custody of a police officer to be dealt with according to law:

SARAWAK STATE FORESTRY DEPARTMENT

National Parks and Wildlife Section

Gunung Mulu National Park

WILDLIFE COLLECTING PERMIT

Permit No ....

The undernamed person is hereby permitted to collect plants or animals of the group(s) specified herein for scientific purposes, within the bounds of Gunung Mulu National Park between the dates of .... and .... using the methods indicated.

THIS PERMIT DOES/DOES NOT AUTHORISE THE HOLDER TO COLLECT IN CAVE HABITATS.

Date of issue	Authorised signatory
....	....

NB. A maximum of five (5) individuals of any one animal species may be collected; unless seriously injured, additional examples taken accidentally must be released alive at the point of capture. Please co-operate with us to preserve the wildlife of this Park.

Name	Passport No ....
Permanent address	Citizenship ....
....	

Permitted groups (e.g. order, family)	Permitted methods:
....	....
....	....
....	....
....	....
....	....
....	....
....	....

BEFORE LEAVING THE PARK, PLEASE COMPLETE THE RETURN ON THE REVERSE OF THIS FORM

Gunung Mulu National Park

WILDLIFE COLLECTING PERMIT

DECLARATION TO BE COMPLETED BY PERMIT HOLDER

I hereby declare that between the dates of .... and .... I have collected the following plant and/or animal species as permitted for scientific purposes.

Date ....   Signature ....

Group (eg. order, family)	Species* (provisional identification if necessary)	No. of individuals or replicates
....	....	....
....	....	....
....	....	....
....	....	....
....	....	....
....	....	....
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....	....	....
....	....	....

(Continue on separate sheet if necessary)

* In the case of ecological or general plant collecting state range of sample or collection numbers.

N.B. This side must be completed and handed to a member of the Sarawak Forestry Department before the permit holder finally leaves Gunung Mulu National Park.

Outline of a proposed survey of the higher primates of Gunung Mulu National Park: material for a grant application, to an appropriate University or Research Council.

OBJECTIVE:

To survey the higher primates in Gunung Mulu National Park in order
(a) to elucidate present distribution, numbers, age and sex structure of populations,
(b) to determine the ecological requirements of each species and
(c) to assess the impact of hunting at current levels in relation to natural mortality; also, at the same time, to investigate similar aspects of the biology of alternative quarry of hunters, notably the bearded pig; and to make recommendations that will take into account long term management objectives.

JUSTIFICATION:

Six species of higher primate occur in the Park: the Bornean gibbon (Hylobates muelleri), the Maroon leaf-monkey (Presbytis rubicunda), the grey (Hose's) leaf-monkey (P. hosei), the silvered leaf-monkey (P. cristata), the long-tailed macaque (Macaca fascicularis) and the pig-tailed macaque (M. nemestrina). Of these, the gibbon and leaf-monkeys have restricted ranges within the Park, being absent from apparently suitable habitat where the incidence of frequentation by man is high. Among leaf monkeys, in addition, observed troop sizes are smaller than normal among related species in undisturbed conditions elsewhere in Malaysia. Interviews, and examination of food remains in contemporary camp sites, have confirmed that these primates are important items in the diet for the Penan hunter gatherers who inhabit the Park. Although it is illegal to do so within Park limits, these monkeys in many parts of Sarawak are also hunted for the sake of bezoar stones (gall stones) which, according to unconfirmed accounts, are found in about one in 70.

All these primates depend for their existence on the availability of forest vegetation. The most specialised for terrestrial tall forest are the gibbon, red and grey leaf-monkeys, all of which are endemic to Borneo. Within recent years, these three species in particular have declined sharply in numbers in many parts of their range. A large reserve of inviolate forest, such as Gunung Mulu National Park, is therefore very important for the ultimate conservation of these species. At the same time, if desired, an adequately protected population of monkeys could be used to provide an annual harvest of animals for human consumption. However, any activity of this nature requires careful management which can only be based on reliable and comprehensive knowledge of each species natural ecology.

Since on one hand there is evidence of current pressure on the Park populations of these primates, yet on the other hand there is also the desire to give the greatest possible liberty to the Penan inhabitants of the Park to pursue their traditional way of life, it is clearly imperative that research be carried out as soon as possible into the biology of the gibbon and monkeys and the impact of man on their populations.

Concurrently, it is important that the investigator should also take account of alternative quarry species hunted by the Penan in the Park, notably the bearded pig (Sus barbatus), assessing numbers density, fecundity, etc., as well as the impact of man. This information is also required for the formulation of a balanced management plan for the Park.

Method: One investigator is sought, probably post-graduate; a married person accompanied by spouse will be considered. The project is likely to be suitable for a graduate research degree and the fullest co-operation will be offered to the academic supervisor of the selected investigator. It is envisaged that 18-24 months fieldwork will be required, during which the appointee will be provided with free accommodation by the Sarawak Forestry Department and the free assistance of one Forest Department Staff member at all times.

Other notes: The appointee will require financial support to maintain him/herself (and spouse, if relevant), and to pay for porters and guides.

It must be assumed that the appointee will make his own arrangements for attachment to a university department. Grant support, however, will need to include fees, etc., and travel to and from the applicant's home.

A draft Park Code

I. The Park is there to be enjoyed by all. Do not pick flowers or needlessly break or trample fragile vegetation. In particular orchids and pitcher-plants are protected. If you are a bonafide-naturalist you may apply for a permit to collect within the Park and your expertise will be welcomed by the National Parks and Wildlife Section. The Warden keeps a log for interesting observations: please add to our knowledge of the Park by recording your observations.

2. The forest is, in places, fragile. Keep to the marked trail for your own safety. Visitors with guides will not need to carry bush knives (parangs) Please do not ask your guides to cut walking sticks from the side of the trail: these may be borrowed from the Warden on request.

3. Fires can be dangerous and often disastrous. The lighting of them is prohibited. Kerosene stoves are provided in all camps. Please make sure you take enough fuel in your baggage for the entire trip as the cutting of firewood, which will be selective for the most flammable species, can be detrimental to the habitat.

4. Do not deface the limestone surfaces which are often clean and invite graffiti. This especially applies in caves.

5. Do not leave litter at camp sites or along the trails. Even the smallest fragment of plastic bag, string etc. will persist and foul the environment. Please leave camp-sites as you would wish to find them. The forest contains a number of rat species that are attracted by unprotected human food. Do not encourage them by leaving behind unwanted, rotting food. Please take all tins, bottles and plastic back to the Ranger's Post.

6. Remember you will enjoy your visit all the more if you can see as much wildlife as possible: please keep quiet.

Scientific projects investigated by members of the Royal Geographical Society/Sarawak Government Expedition 1977-78.

Ref.	Title and/or scope	Investigator(s)
BOTANICAL		
B1	To study and map the vegetation formation of the Park to provide a base line for a Management Plan of the Park.	J.A.R. Anderson P. Chai and Forest Dept. team
B2	Comparative ecological studies on the nutrient partitioning of four major forest formations, namely alluvial, mixed lowland dipterocarp Kerangas and limestone lowland forest. A major key project of 15 months duration.	J. Proctor S.C. Proctor H. Vallack J. M. Anderson N. M. Collins
B3	A general survey of the Park to study the Ericaceae; collections made for the study of the vascular flora of the area generally.	G. Argent J. A. R. Kerby S. Leche
B4	Similar studies with specialisation in Leguminosae.	G. Lewis
B5	A survey of the Bryophyta especially Bryopsida of the Park.	A. Touw
B6	A survey of the pteridophyta with emphasis on the upper montane forests of the Mulu formation.	B. Croxall J. Croxall
B7	A similar survey with emphasis on lowland forest and limestone areas and including a cytological survey of all species of pteridophytes encounted.	A. C. Jermy T. G. Walker
B8	A survey especially of the altitudinal zonation of selected Mimosoideae and collecting generally for the inventory of plant species.	I. C. Nielsen
B9	To collect phanerogams in hitherto uncollected areas and to study especially the Melastomataceae.	C. K. Hansen
B10	To collect and photograph fungi over a wide range of habitats of the Park.	W. F. B. Jülich

B11	To study the herb layer of lowland rain forest on limestone, alluvium and the Quaternary terraces.	R. Kiew
B12	To study the flora generally in lowland forests and in particular the Pandanaceae and Rutaceae of the limestone lowland forests.	B. C. Stone
B13	To study and collect the lichenised fungi especially of the upper montane forest and ridge communities.	B. Coppins
B14	To make a brief but concentrated survey of the palm flora of the Park.	J. Dransfield
B15	To collect lichens in the lowland forests.	N. Sammy
B16	To survey the distribution of uwud (Eugeissona utilis) and collect palms in the Hulu Mentawai.	T. C. Whitmore

ZOOLOGY

Z1	To investigate the distribution of the macro fauna, especially birds and mammals in relation to forest type.	Lord Medway (Cranbrook) D. Labang
Z2	To study the altitudinal zonation of amphibia and to record frog and toad calls.	J. C. Dring
Z3	To collect and observe selected orders of insects especially Hemiptera and short-horned grasshoppers (Acridoidea).	D. Hollis
Z4	To collect and observe ants (Hymenoptera: Formicidae in alluvial forest.	B. Bolton
Z5	Studies on the passerine bird fauna of lowland dipterocarp forest, in particular the co-existence mechanisms in the bird genus Stachyris (Timalidae).	K. McCormick
Z6	The influence of floristic and vegetational changes on the abundance and diversity of birds within the lowland forest formation on G. Mulu.	D. R. Wells C. J. Hails S. A. Hails

Z22	To collect and study the behaviour of the arachnid fauna of selected habitats.	P. R. Wanless
Z23	To study the basis of mimary in the butterfly family Danaidae.	A. L. Panchen
Z24	A preliminary study of the primates of the lowland forest formations; alluvial Kerangas and dipterocarp.	A. W. Mitchell P. M. H. Leworthy
Z25	To study the immature stages of beetles of various habitats, especially forest litter, soil and decaying wood.	J. E. Marshall
Z26	To study the ecological status of the bat fauna in Gua Payau.	S. C. Proctor
Z27	To study the physical and chemical environment of the rivers Melinau, Tabaun, Berar and Lutut.	R. P. Lim J. I. Furtado K. S. Liew

GEOMORPHOLOGY

GI	To study the rates of erosion and formation of the land-forms extending over an altitude range of 2,400 m. Included climatological recording for I5-months.	M. Sweeting R. P. D. Walsh M. J. Day
G2	To study the processes involved in Karren formation and maintenance and the relationship of Karren to lithological and environmental factors.	H. A. Osmaston
G3	To study and map the major soil types in conjunction with the vegetation survey.	C. P. Lim E. H. Lim I. Baillie T. T. Khiong C. Phang Y. L. Tie
G4	To survey the cave systems and report on their potential for tourism and scientific research.	A. C. Waltham D. Brook & A. J. Eavis M. Farnworth M. K. Lyon
G5	To study cave clay sediments and chemical composition of ground waters	M. Laverty
G6	To sample certain parts of the Melinau Limestone for micro-palaeontological and magneto-stratographical study.	K. T. Yap T. Ooi

Z7	Observations on the breeding populations of montane passerine species of birds.	J. Croxall B. Sage
Z8	To study the status pheasant species (Phasianidae) in the National Park.	G. W. H. Davison
Z9	An investigation of the distribution and status of fish in selected major river systems of the Park.	J. Cramphorn
ZIO	To study the litter fauna of the major forest formations and assess the ecological status of centipedes and millepedes (Myriapoda).	J. C. Lewis
ZII	To study and collect Homoptera, particularly aphids, around the Park.	V. F. Eastop
ZI2	To study the beetles of litter and other substrate habitats found in the Park with emphasis on Staphylinidae.	P. M. Hammond
ZI3	To study the lowland and mid-montane amphibian fauna of the Park.	B. H. Kiew
ZI4	To survey the Lepidoptera with special reference to altitudinal zonation; a major 5-month project.	J. D. Holloway
ZI5	An investigation into the role of termites in the ecology and decomposition of rain forest of the Park; a major I2-month project.	N. M. Collins
ZI6	To observe and record the calls of lowland and montane birds.	B. King
ZI7	To collect vertebrate blood samples for parasite content.	W. Peters C. M. Saunders
ZI8	To radio-tag and study the behaviour of selected mammals of the alluvial forest.	D. Macdonald M. Wise
ZI9	To study habitat selection, temperature preferences food type and activity periods of selected lizard species in lowland alluvial forest.	I. R. Swingland
Z20	To study beetle diversity within and between selected forest habitats around the Park.	I. Hanski
Z2I	An investigation of the cave faunas.	P. Chapman

G7	A study of the geomorphology of the Quaternary terraces of the Tarikan-Melinau valleys.	C. Woodroffe
G8	To study the hydrology and chemistry of diffuse flow within the limestone aquifer.	H. Friederick
G9	A study of limestone dissolution dynamics and Karst micro-morphology in the Park.	D. L. Dunkerley
GIO	An investigation of the forms and processes involved with the limestone towers and other Karren types throughout the area.	R. McDonald R. Ley

ETHNOLOGY

EI	To study the human-ecology of the Penan living within and around the Park and an assessment of their ecological status within the Park ecosystems.	P. M. Kedit A. J. U. Anderson and Sarawak Museum team

Job description/terms of reference for the post of scientific and technical Assistant to Warden

1. To assist the Park Warden on a day-today basis in the supervision of the general progress of development of the Park as laid out in the Management Plan.

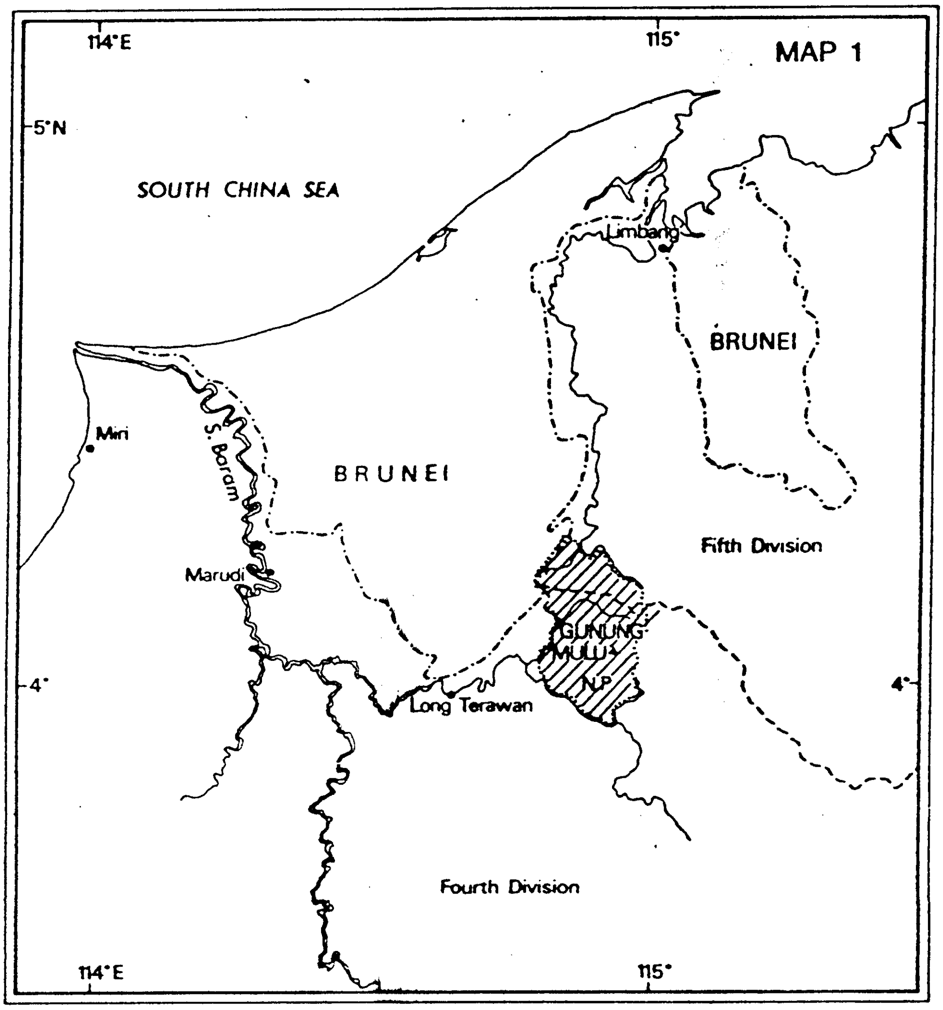
2. To assist and advise on the detailed application of the Plan, taking account of features of scientific importance.

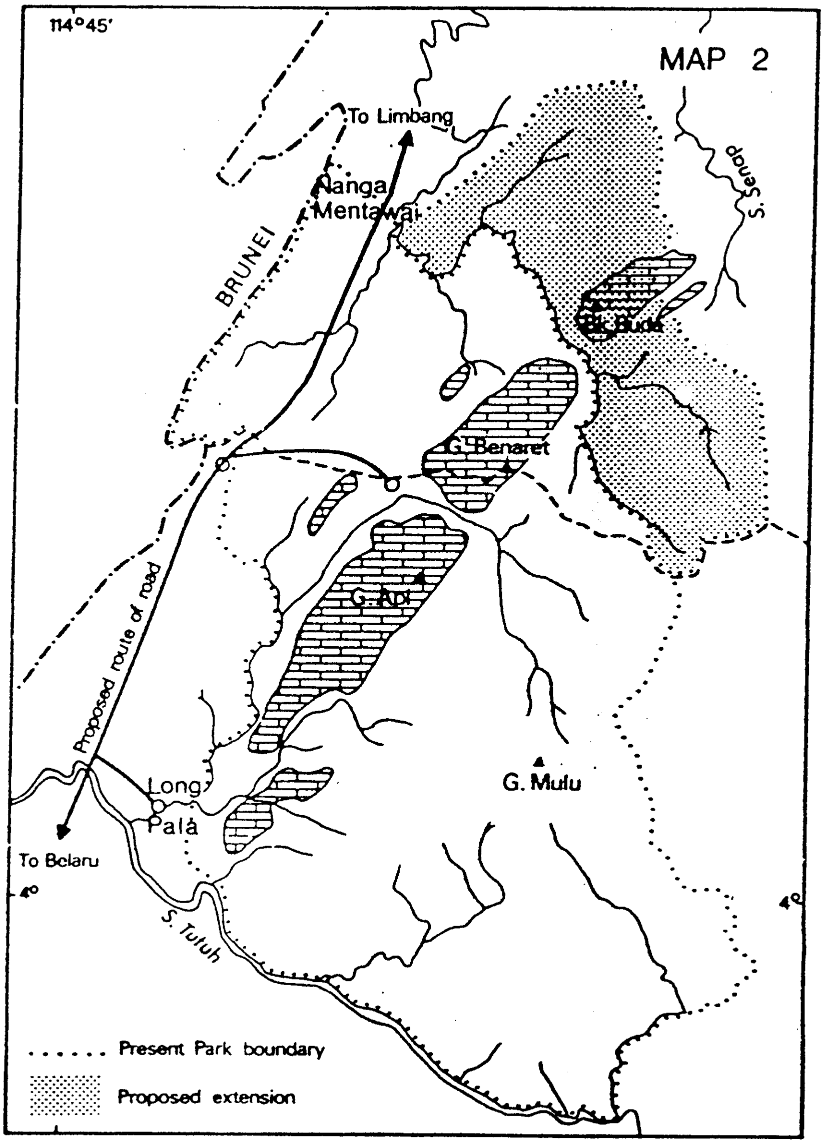
3. To institute a system of keeping events records and to initiate a register of all plants and animals found in the Park.

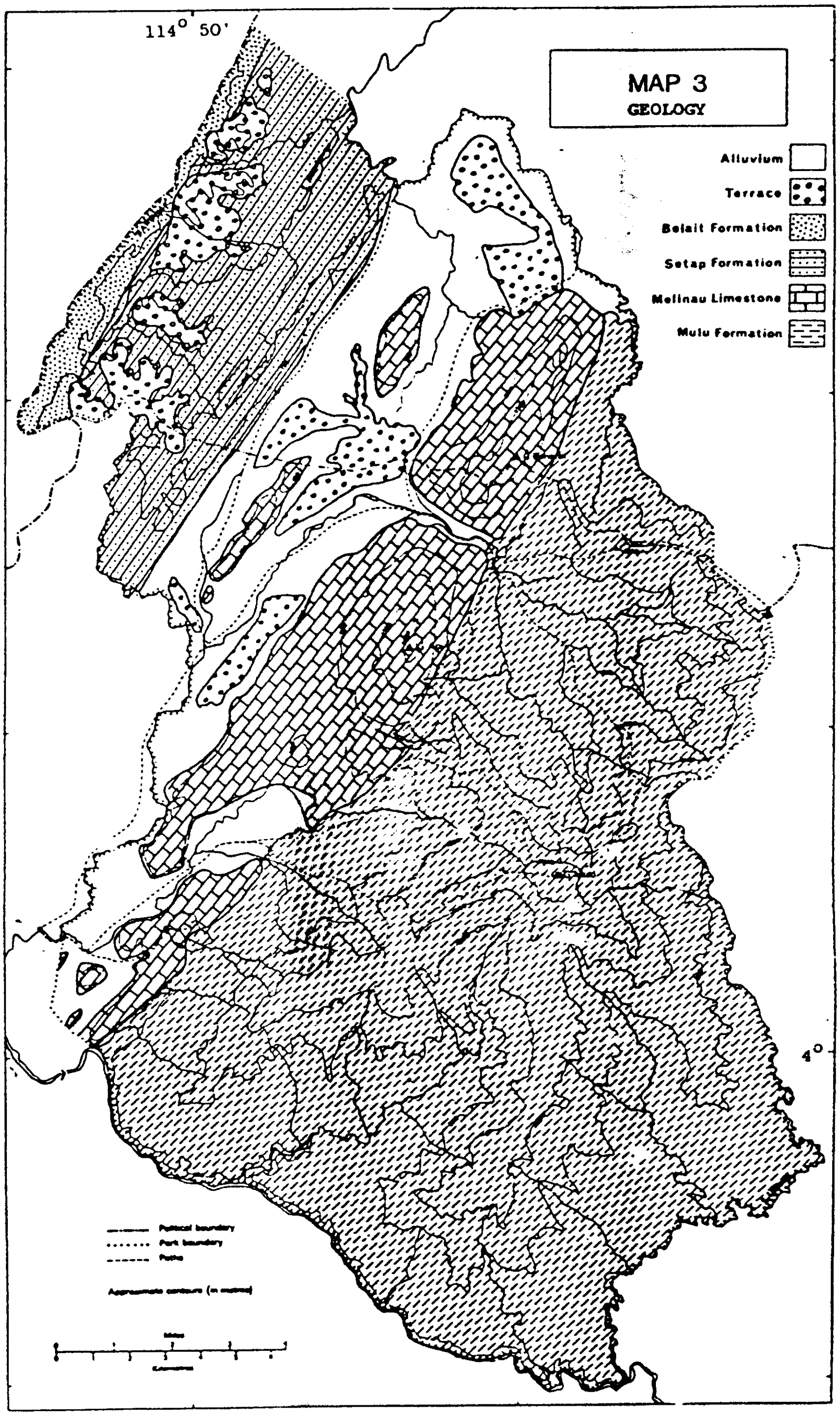
4. To monitor the recreational, educational and scientific use of the Park and to act as the liaison officer between visiting scientists and the Warden and his staff.

5. To appraise the Head of National Parks Section of the scientific aspects of the Park in relation to management and development and, especially, during the building of the highway and roads to act as liaison officer with J.K.R.

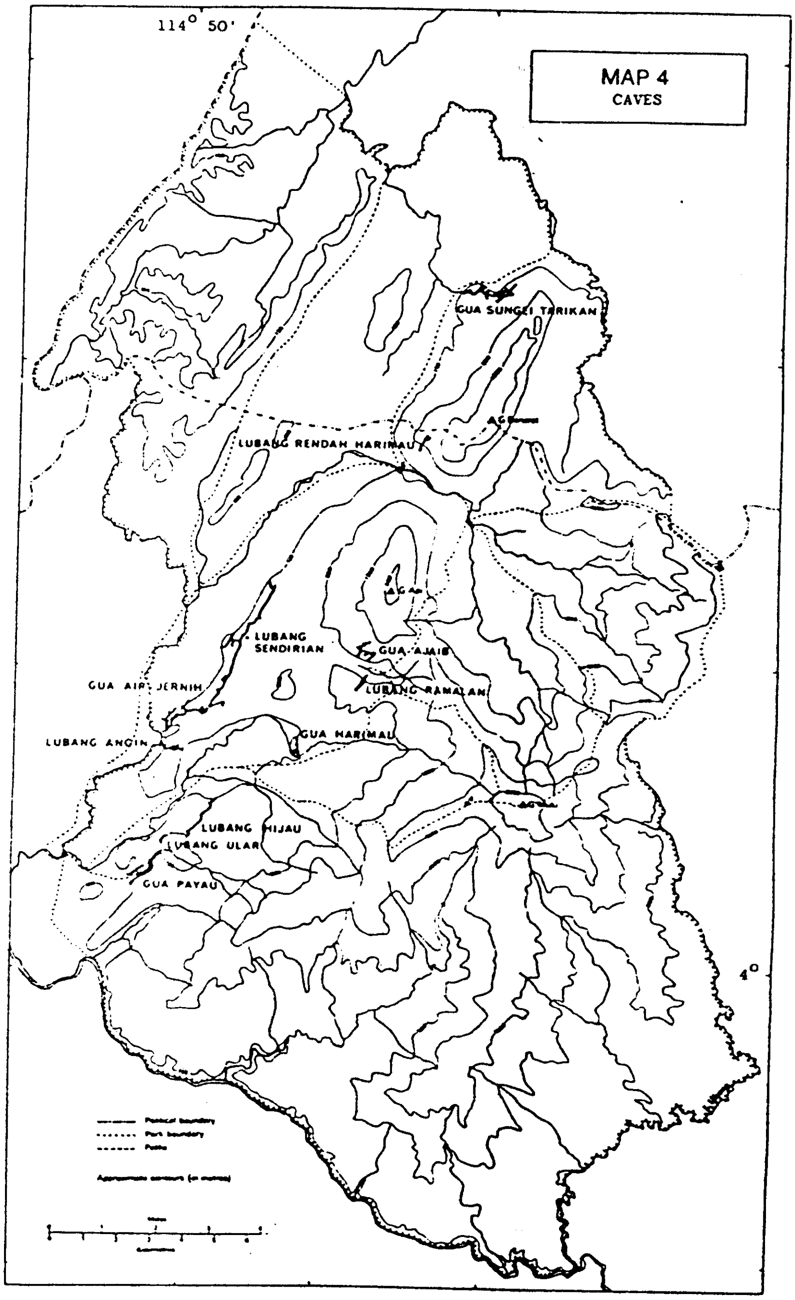
6. To produce descriptive interpretive material for the visitor centre and prepare copy for educational leaflets.

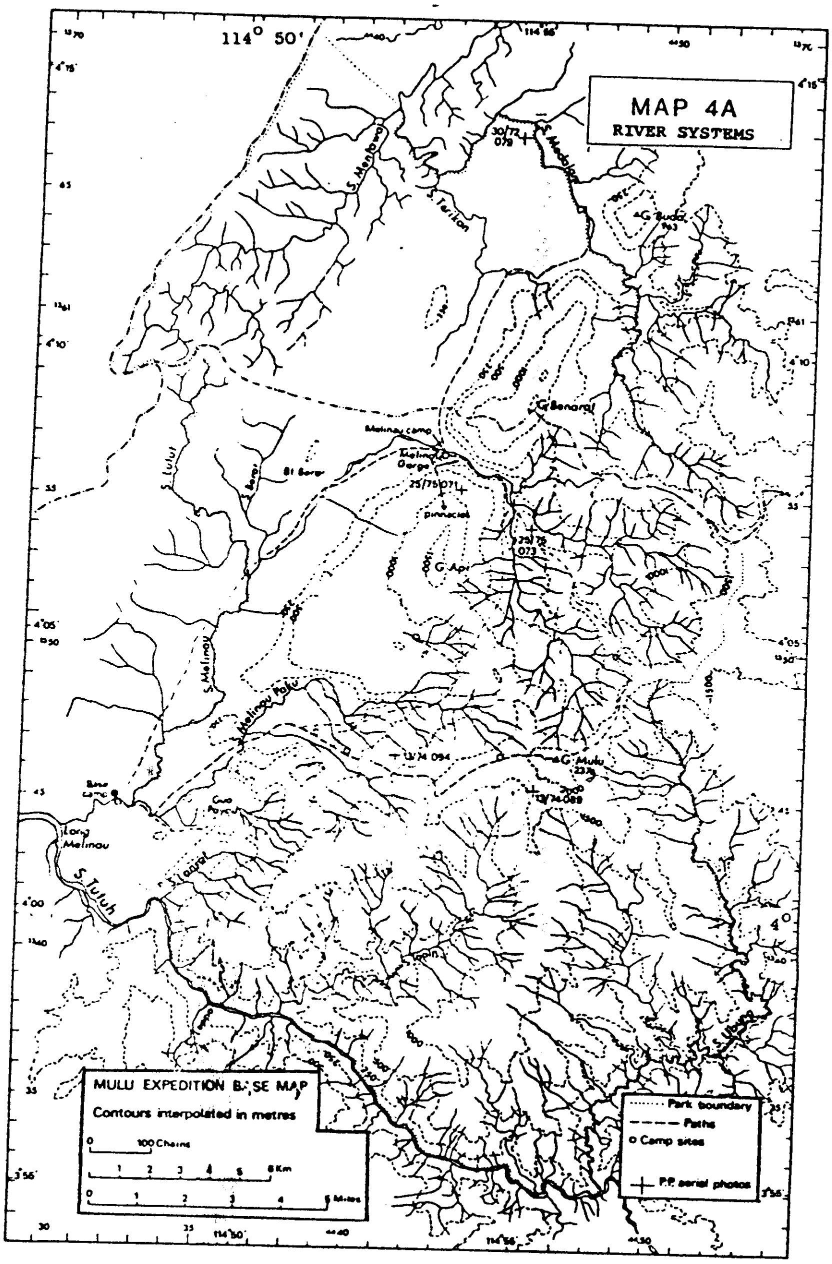

MAP 1
114°E
115°
5°N
SOUTH CHINA SEA
Limbang
BRUNEI
Miri
S. Baram
BRUNEI
Fifth Division
Marudi
GUNUNG MULU N.P.
4°
Long Terawan
4°
Fourth Division
114°E
115°


114°45'
MAP 2
To Limbang
Nanga
Mentawai
BRUNEI
S. Senap
G. Benaret
G. Api
Proposed route of road
Long
Pala
G. Mulu
To Belaru
4°
4°
S. Tutuh
Present Park boundary
Proposed extension

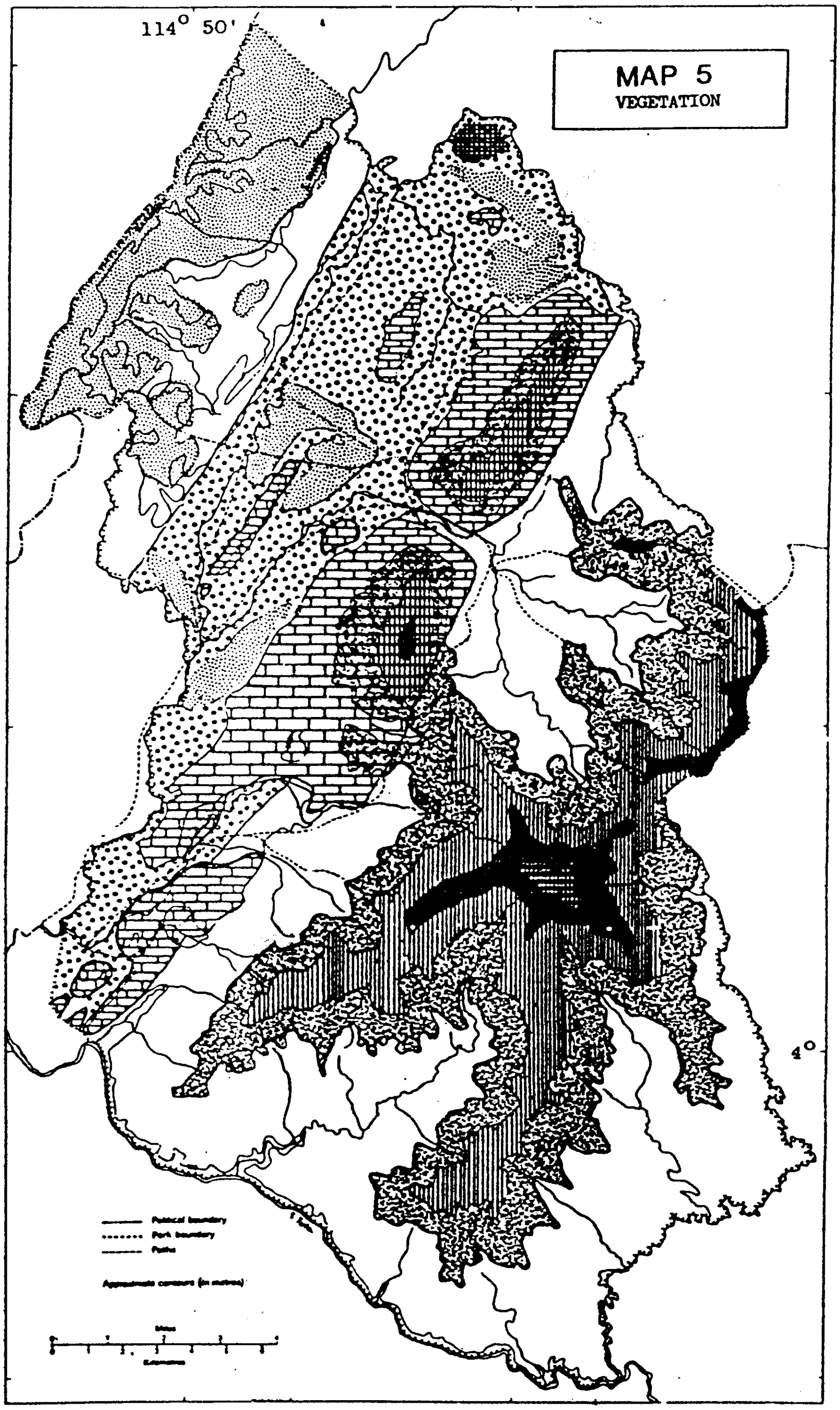


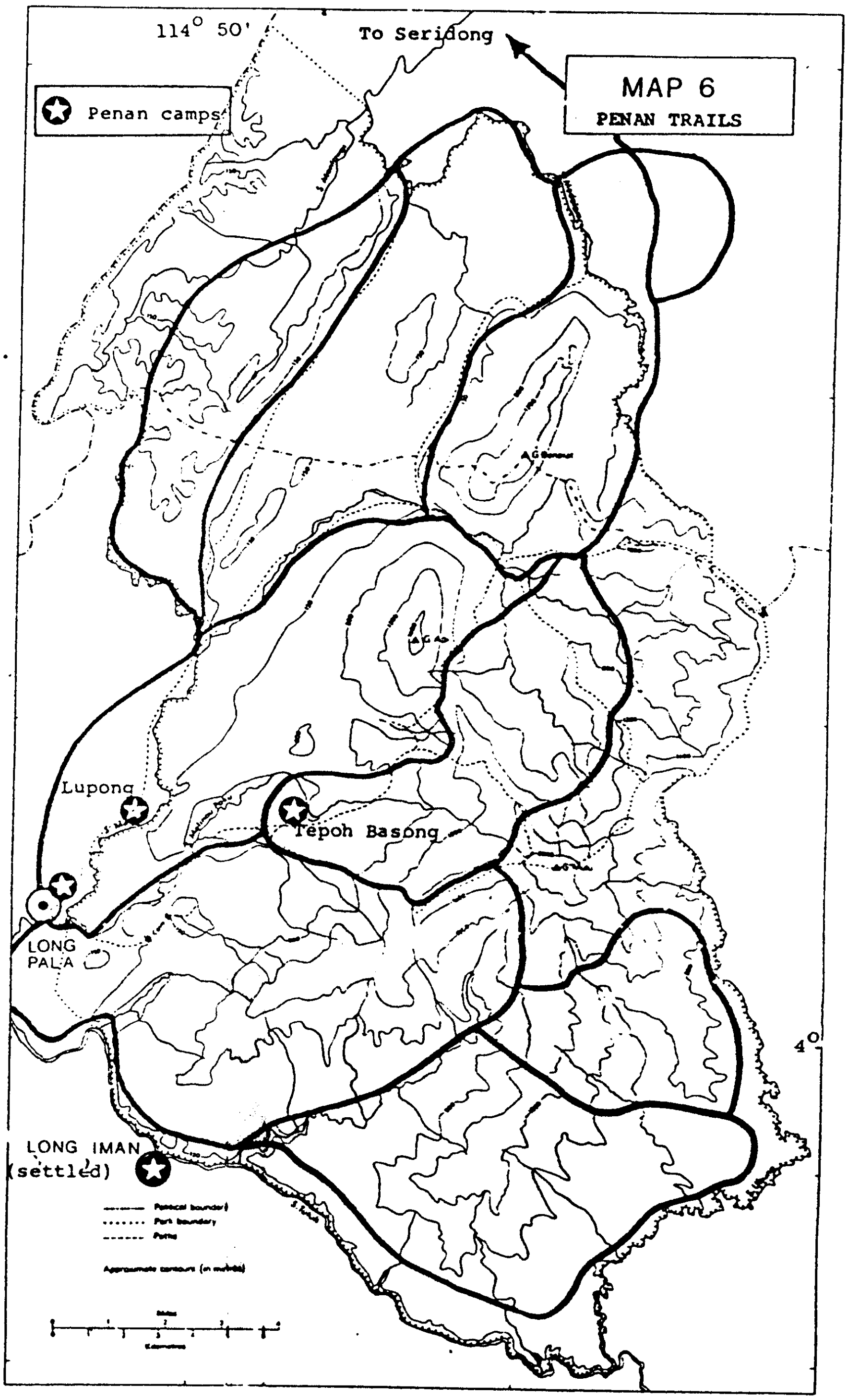
114° 50'
MAP 3
GEOLOGY
Alluvium
Terrace
Belait Formation
Setap Formation
Melinau Limestone
Mulu Formation
4°

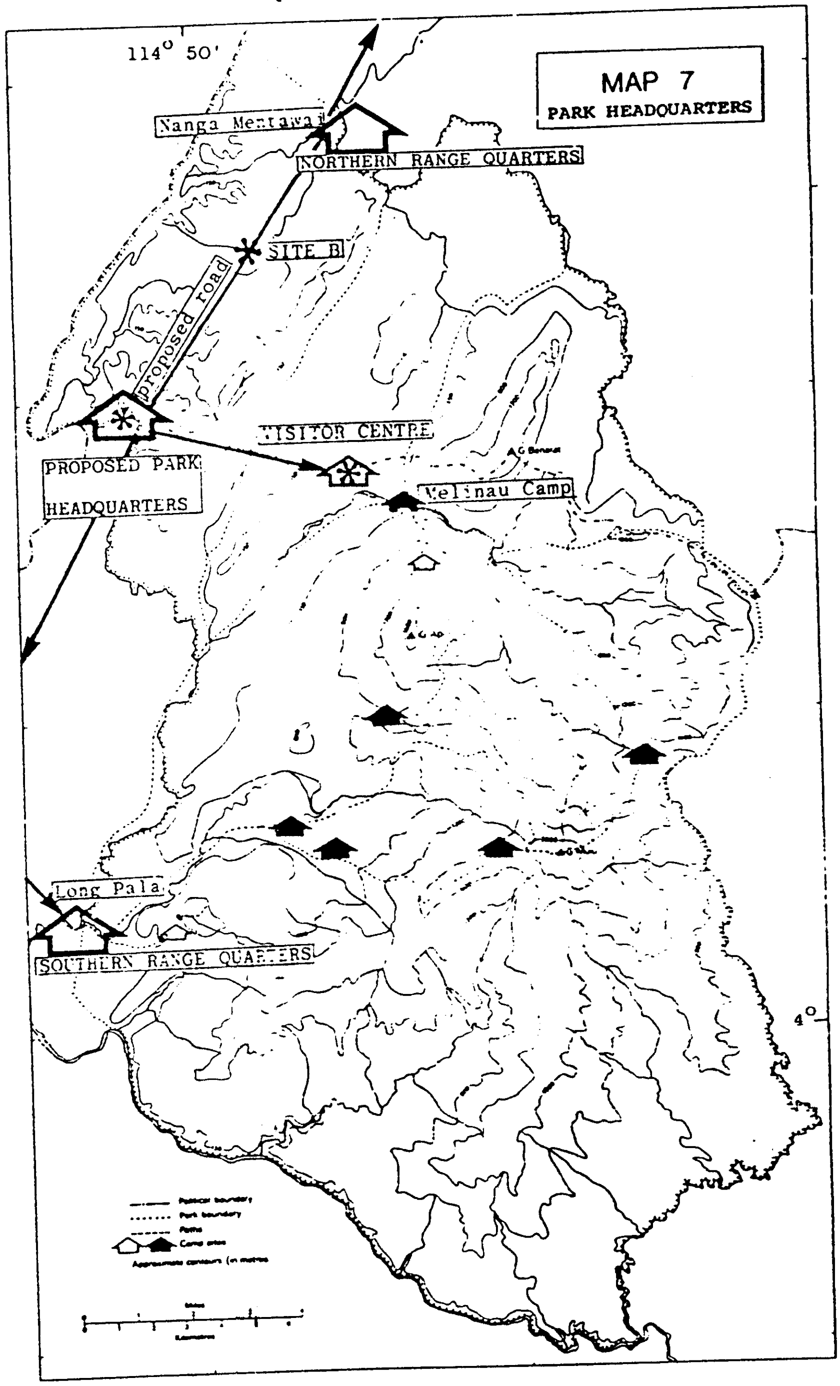

MAP 4
CAVES
114° 50'
GUA SUNGEI TARIKAN
LUBANG RENDAH HARIMAU
LUBANG SENDIRIAN
GUA AJAIB
LUBANG RAMALAN
GUA AIR JERNIH
LUBANG ANGIN
GUA HARIMAU
LUBANG HIJAU
LUBANG ULAR
GUA PAYAU
4°



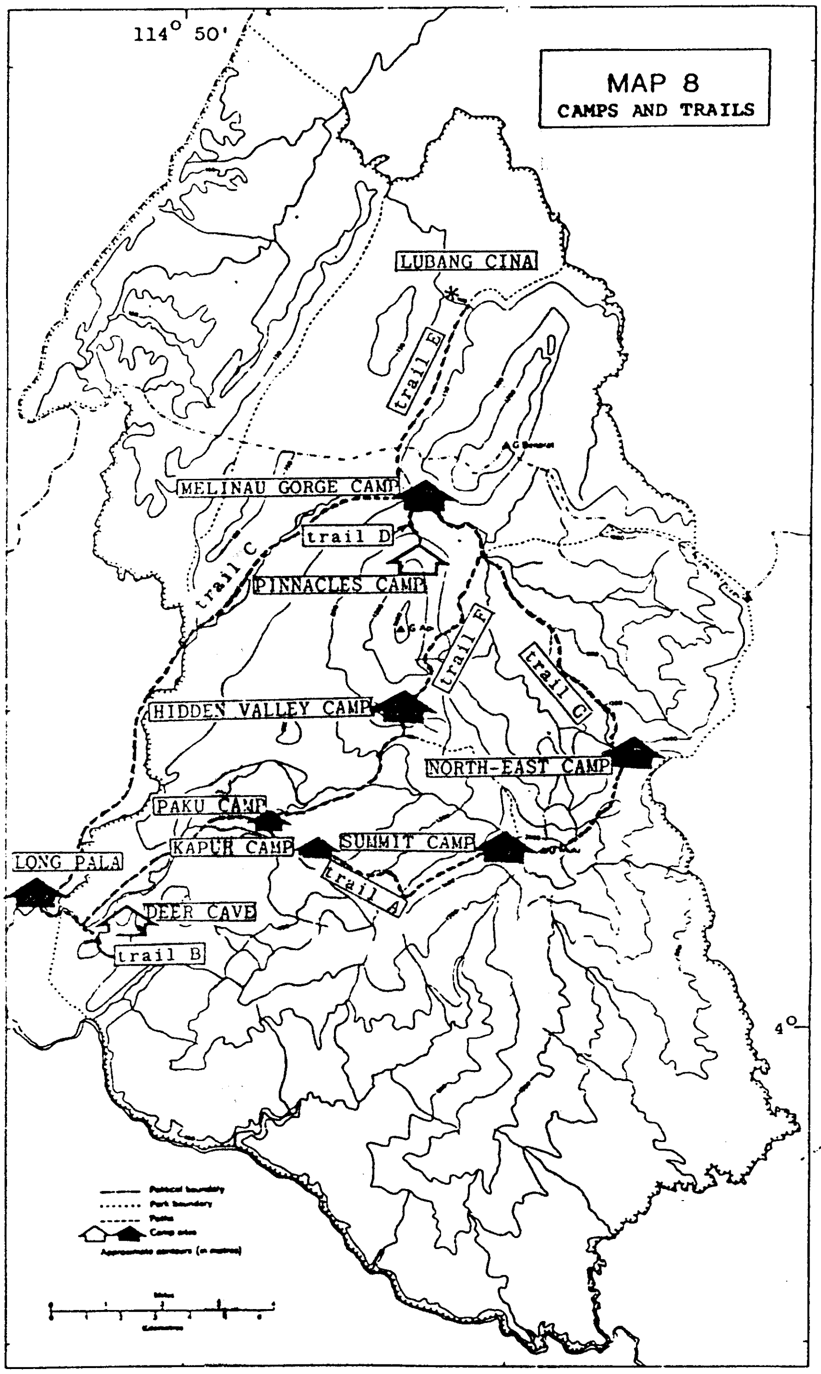
MAP 4A
RIVER SYSTEMS
114° 50'
G. Benarat
Melinau camp
Melinau Gorge
pinnacles
G. Api
G. Mulu
S. Melinau
S. Melinau Paku
Base camp
Long Melinau
S. Tutoh
MULU EXPEDITION BASE MAP
Contours interpolated in metres
100 Chains
Km
Miles
Park boundary
Paths
Camp sites
P.P. aerial photos


114° 50'
MAP 5
VEGETATION
4°


114° 50'
To Seridong
MAP 6
PENAN TRAILS
Penan camps
Lupong
Tepoh Basong
LONG PALA
LONG IMAN (settled)
4°



MAP 7
PARK HEADQUARTERS
114° 50'
Nanga Mentawai
NORTHERN RANGE QUARTERS
SITE B
proposed road
VISITOR CENTRE
PROPOSED PARK
HEADQUARTERS
Melinau Camp
Long Pala
SOUTHERN RANGE QUARTERS
4°


114° 50'
MAP 8
CAMPS AND TRAILS
LUBANG CINA
trail E
MELINAU GORGE CAMP
trail D
trail C
PINNACLES CAMP
trail F
trail C
HIDDEN VALLEY CAMP
NORTH-EAST CAMP
PAKU CAMP
KAPUR CAMP
SUMMIT CAMP
LONG PALA
trail A
DEER CAVE
trail B
4°

The Limestone Pinnacles Of

Gunung Mulu National Park

GUNUNG MULU NATIONAL PARK

MANAGEMENT PLAN 1993 - 1995

December 1992

Sarawak Forest Department

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PREFACE

The planning for and creation of a system of national parks and other totally protected areas for the protection and conservation of biodiversity and also to serve a variety of human needs has emerged among the top items in development agendas of many countries in the world.

Merely establishing areas as national parks or other totally protected areas would not achieve all the objectives intended. For maximum results and effectiveness management plans for these areas are very necessary. A management plan for a national park or any equivalent reserve is a dymanic plan which changes according to the requirements of time.

Gunung Mulu National Park established in 1974 had its management plan prepared in 1979 by the Royal Geographical Society after an extensive resource inventory of the park. Since then Gunung Mulu National Park has attracted attention worldwide because of the wide publicity on its natural attributes, e.g. the virgin tropical rainforest and its flora and fauna, and the intriguing limestone caves formations. The number of visitors to the park had steadily increased and with the opening of the Mulu airstrip the increase in the number of visitors will be manyfolds. The steady increase in the number of visitors had resulted in the establishment of numerous private accommodations outside the park, and also increased pressures on the park resources. These developments had prompted the Government to prepare a revised management plan for Gunung Mulu National Park. This plan will chart out strategies and programmes for the park management for the period 1993 - 1995.

This Management Plan consists of 4 main components: (a) General Background of the Park; (b) Assessment of Park resource; (c) Assessment of current Park use; and (d) Management strategies and programmes. The budget estimates for the programmes to be implemented for the 1993 - 1995 period are also tabled in this management plan. In endeavouring to be thorough in its management approach and this plan has included aspects of human resource development and administration, park administration, law enforcements, zoning, carrying capacity, visitor use, interpretation & extension, wildlife management, research and most importantly community development.

Community development is especially included in this management plan because of the realisation of the need for the support and cooperation of communities adjacent to the park for the smooth running of the park. The communities living adjacent to the park has every reason to benefit from the park and to see that the park continue to exist.

This plan when implemented expects the overall improvement in most if not all the parameters mentioned above.

ACKNOWLEDGEMENT

The compilation of the Gunung Mulu National Park Management Plan 1993 - 1995 is the result of the untiring efforts and contributions of a team of people.

We wish to thank the Director of Forests, Datuk Leo Chai and Deputy Director of Forests, Abang Haji Kassim bin Abang Morshidi for their guidance and concurrence in the preparation of the plan.

The National Parks and Wildlife Office staffs, namely, the National Parks and Wildlife Officer, Mr. Ngui Siew Kong, Mr. Oswald Braken Tisen, Mr. Desmond Dick Cotter, Mr. Simon Sandi, Mr. Melvin Gumal, Mr. Engkamat Lading, Mr. Francis Gombek, Mr. Gary Tay and En. Saip Sulong worked hard in contributing to and editing the various sections of the plan.

We are very grateful for the expertise and inputs of Dr. Liz Bennett and Mr. Mike Meredith, both staffs of Wildlife Conservation International.

Many thanks also goes to Ms. Lim Mong Tze for her patience in typing and wordprocessing.

OVERVIEW

INTRODUCTION

Chapter 1 of the Plan gives a brief description of the Park Section 1.2 sets out the Scope of the Plan with brief reference to major management problems which lie outside the jurisdiction of the Department. The shortfall of precious plan implementation and the course of action to be taken are also given.

DESCRIPTION

Chapters 2 and 3 describe the Park resources and surroundings in detail. The Resource Assessment (section 3.5) is particularly important for management. Chapter 4 covers the present land-use situation in the Park.

STRATEGY

Chapter 5 deals with arrangement objectives and strategies, including management zonation and visitor carrying capacity.

PROGRAMMES

Chapter 6 sets out details of the management programmes which will be implemented during the period of the Plan. Section 6.8 sets out a year-by-year schedule for implementation. Chapter 7 gives details of the budgetary requirements.

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1.3 IMPLEMENTATION AND MONITORING

It is now generally recognised that arrangements for monitorin implementation of plans are vital. In the light of this some kin of formal review procedure does need to be set up. Monitorin provides a feedback that will enable prescriptions to be revise periodically.

1.4 RESULTS OF PLAN IMPLEMENTATION

No plan period and detailed prescription are given in the previou plan. Nevertheless the previous plan had served as guidelines i the Management of the Gunung Mulu National Park.

A number of action programmes have been implemented. Among thes are, Park Protection, Visitor Management, Construction of Par Headquarters, and Ranger Post and community development. Th results are quite encouraging.

There are also shortfalls. As the Pan-Sarawak Highway did not materialize, river transport was still popular. This resulted in the siting of park headquarters further down the Melinau River. Besides, shortage of trained manpower had affected park management. For example, the effect of hunting on wildlife is yet to be ascertained.

The 1993 - 1995 plan therefore, takes into consideration the various constraints and limitations, ecological requirement of the Park, the needs of the local communities as well as tourism benefits. It will seek to improve the overall situation in the park.

A projection of the status of the various parameters by the end of 1995 is listed below and are qualified as follows:

1 - Status significantly improved;
2 - Status moderately improved;
3 - Status remains the same;
4 - Status moderately deteriorates;
5 - Status significantly deteriorates.

Parameters	Present Status	Status at end of 1995
a) Park administration	Moderate	2
b) Visitor management & service	Moderate	2
c) Visitor satisfaction	Moderate	2
d) Public relations	Moderate	2
e) Wildlife management & research	Needs improvement	2
f) Law enforcement effectiveness	Needs improvement	1
g) Wildlife Populations	Needs improvement	2
h) Park environment status	Good	3
i) Watershed management & Protection	Good	3
j) Income generation to local villagers from tourism	Moderate	2
k) Income generation to the region from tourism	Good	3
l) Living standards of villages near the park	Moderate	2

2.2.2 Penan

By 1962, there were approximately 651 Penans occupying land between Sungai Melinau and the Sarawak/Brunei border, and along Sungai Tutoh and its tributaries. About 1974 a Penan group decided to settle permanently at Long Iman. In 1977 and 1978, groups of Penan were living on the Sungai Pala in the Melinau Paku area; by 1980 these two groups had concentrated at Sungai Pala with the intention of settling permanently, and had begun to cultivate rice; however, this site is not accessible by boat, so the group later (ca. 1982) moved to the present settlement site at Batu Bungan.

2.2.3 Berawan

Shackleton, who visited the area in 1932, reported that Berawan from Long Terawan had established farms near the site of the old fort at Long Melinau (Harrison **). Old aerial photographs showed abandoned farm land around Long Pala but no houses in the area, a situation which persisted until 1984.

Repopulation of the Melinau valley began when the Park was opened to visitors. It increased in random with tourism development Nine travel agents have built their own lodging houses for tourists near the Park, and Berawan employed by the operators or by NPWO have reoccupied large areas of farmland along the boundary.

2.2.4 Expected trends

The population of the Mulu area is likely to increase dramatically with the coming of the Mulu Resort Hotel, airstrip and Civic Centre, all of which encourage people to come, work and settle down in the area.

2.3 REGIONAL ACTIVITIES

Sarawak's National Parks and Nature Reserves Ordinance makes no provision for buffer zones outside park boundaries. This means that Totally Protected Areas are in direct contact with disturbed areas outside the boundary. The undisturbed area outside the Park is, in reality, much less than the area of the Park, and policing of the boundary is less effective.

Where a river forms the Park boundary, disturbance on the opposite bank seriously affects the riverine habitat and the quality of the water.

Figure 2 shows the activities adjacent to the Park boundary.

2.3.1 Promotion of tourism (carrying capacity)

The Park can only cater for a certain number of visitors, because of physical, environmental or perceptual limitations. The carrying capacity of the main recreational sites is discussed in Section # 5.3, where we conclude that visitation of the show caves with current facilities must be limited to 760 person per day and could be increased to 2950 person per day with additional staff.

Meanwhile, accommodation for 1000 visitors is already available in and adjunct to the Park. It will not be long before the park can take no more visitors.

2.3.2 Land for Penan

The Government is providing a range of facilities for the Penan at Batu Bungan, immediately outside the Park boundary, and is encouraging them to concentrate and settle in the area. However, people from the longhouse at Long Terawan claim Native Customary Rights over the whole area. Conflict over land restricts the farming activities of the Penan, and this means that they rely heavily on hunting and gathering, mostly within the Park.

Without settlement of land claims and availability of land for the Penan, the policy to centralis the services at Batu Bungan will lead to extensive damage to the natural resources of the Park.

2.3.3 Sale of handicrafts

The influx of tourists to Mulu has created a market for traditional handicrafts. These sales are encouraged by the Government as a way for rural people to benefit from tourism. The Penan of Batu Bungan sell large number of rotan bags and also mats, bracelets and blowpipes. Rotan does not grow in the cultivated area outside the Park, and large amounts are collected within the Park.

The levels of collection are unsustainably high, and the species of usable rotan will soon disappear from the more accessible areas of the Park.

2.3.4 Tour operators' standards

The service provided by some of the tour operators is of low standard. Some operators appear to be more concerned with immediate financial gain than with the long term future of the tourism industry. Unfortunately, visitors do not always make a clear distinction between private sector services and those of the Park. The efforts of NFWO to provide a quality experience for visitors is, in some cases, undermined by shoddy service of private operators.

has made the Park world famous, is the Melinau Limestone. This forms a line of spectacular mountains running from south-west to north-east across the heart of the Park, just north-west of Gunung Mulu. The formation itself comprises four main blocks: the southern hills, G. Api, G. Benerat and G. Buda. Deep gorges intersect them, the most spectacular being Melinau Gorge cutting deeply between G. Api and G. Benerat.

On the outer surface of the limestone, the heavy rainfall has combined with the geology of the limestone to produce ridges and deep depressions, and also groves of towering limestone pillars separated by deep fissures. Most spectacular of these formations are the "Pinnacles" on the northern side of G. Api (Osmaston and Sweeting, 1982).

Inside the Melinau Limestone, the combination of mechanically strong limestone, widely spaced cracks in the rocks, very heavy rainfall and a long geological time period has produced one of the most spectacular cave systems in the world (Eavis, 1985; Meredith *et al.*, 1992). The passage density alone is outstanding, with at least 3% of the volume in parts of the formation being void (Eavis, 1985). Sarawak is universally known because the Park contains the world's largest cave passage in Deer Cave, and the world's largest known cave chamber, the Sarawak Chamber. At 600 m long, 415 m wide, 300 m high, with a volume of 12 million cu m, and a floor area of 162,700 m^2, the Sarawak Chamber dwarfs all other known chambers in the world. The next largest, in Spain, has a floor area of a mere 76,620 m^2 (Meredith *et al.*, 1992). Clearwater Cave is also one of the world's longest caves. Almost every cave expedition that goes to Mulu finds that the system is longer than previously thought. By 1992, it was known to extend for 100 km, making it the seventh longest cave in the world (Meredith *et al.*, 1992).

Altogether, the limestone is thoroughly riddled with vast networks of caves, some small, some vast, some relatively simple, some spectacularly beautiful with their gothic arrays of diverse stalactites, stalagmites, rivers and rock formations (for photographs, see Tsen, 1991; Meredith *et al.*, 1992). They include Deer, Snake and Green Caves in the Southern Hills; Cave of the Winds, the Sarawak Chamber, Lagang's, Clearwater, Cobra, Drunken Forest and Black Rock Caves in G. Api; Benerat Caverns, Tiger, Cobweb and Terikan River Caves in G. Benerat, and Beachcomber, Turtle and Compendium Caves in G. Buda, as well as many more yet to be discovered, mapped and named (Brook *et al.*, 1982; Eavis, 1985; Meredith *et al.*, 1992).

3.3 FLORA

Gunung Mulu National Park contains a remarkable diversity of vegetation: almost all of the major inland vegetation formations in Sarawak occur in the Park (Anderson and Chai, 1982; Table 1). The reason for such diversity is the variety of geological formations, and the wide range in altitude which results in the different climate zones (Section 3.2). The land types and associated vegetation formations are quite discrete, and can be recognised easily from the air (Anderson *et al.*, 1982; Anderson and Chai, 1982). They are listed in Table 1, and the following description of the forests is drawn from Anderson *et al.* (1982) and Anderson and Chai (1982).

Table 1. Land types and associated vegetation formations in Gunung Mulu National Park (from Anderson and Chai, 1982).

Land types & sub-types	**Vegetation formation**
Gunung Mulu Massif	
1. Up to 800 m	Lowland mixed dipterocarp forest
2. 800 - 1200 m	Lower montane forest
3. 1200 - 1900 m	Upper montane forest (tall facies)
4. 1600 - 2177 m	Upper montane forest (short facies)
5. 2177 m - summit	Upper montane forest (summit facies)
Melinau limestone	
1. Scree slopes	Lowland limestone scree forest
2. Cliffs	Lowland limestone cliff communities
3. Slopes, up to 800 m	Lowland limestone forest
4. 800 - 1200 m	Lower montane limestone forest
5. 1200 m - summit	Upper montane limestone forest
Alluvial plain	
1. Alluvium	Lowland alluvial forest
2. Quaternary terraces	Kerangas or tropical heath forest
3. Peat swamps	Peat swamp forest
Setap shales in Mentawai drainage	
1. Setap shale formation	Lowland mixed dipterocarp forest
2. Mentawai drainage	Kerangas or tropical heath forest

GUNUNG MULU MASSIF

The lowland mixed dipterocarp forest (MDF) comprises the tallest and most diverse of the forest types. Emergents rise to about 55 m high, and with boles exceeding 250 cm girth. 284 species of trees were recorded in sample plots totalling 1.2 ha in this forest. Trees in the family Dipterocarpaceae predominate, and particularly common genera include *Calophyllum*, *Diospyros*, *Durio*, *Eugenia*, *Garcinia*, *Shorea and Xanthophyllum*. At lower altitudes, the most frequently recorded species are *Dryobalanops beccarii and Shorea scaberrima*, and at higher altitudes they are *Artocarpus lancefolius* and *Shorea obscura*.

In lower montane forest, trees are not as tall. The tallest only reach heights of about 30 m, and few trees exceed 180 cm girth. In general, there are more smaller trees than in lowland MDF. The forest is still floristically rich, with 225 species of trees recorded in 0.5 ha. Dipterocarpaceae are less diverse and less dominant here. At lower altitudes, Fagaceae, Guttiferae and Myrtaceae are common, whereas Flacourtiaceae and Sapotaceae become important at higher elevations. *Quercus subserica* is the most common large tree at lower elevations. Palms are relatively diverse and abundant, including small rattans and wild sago (*Eugeissona utilis*).

At about 1200 m a.s.l., there is a marked change in vegetation to upper montane forest (tall facies). Soils are peaty and damp, and bryophytes and lichens adorn the lower stems of trees and hang from the crowns. The forest is dense and difficult to penetrate because of the large numbers of small trees, with few exceeding 120 cm girth. The main canopy is only about 15 m high, although a few scattered emergents reach 21 m. Diversity is reduced, with only 155 species of trees in 0.365 ha. Guttiferae and Myrtaceae are common families here. Widespread and abundant species include *Calophyllum teysmannii* var. *inophylloidae*, *Eugenia palembanica* and *Prunus arborea* var. *stiplacea*. Two conifers are also common: *Dacrydium beccarii* and *Phyllocladus hypophyllus*. Scrambling bamboo (*Racemobambos glabra*) is abundant.

Upper montane forest (short facies) comprises a dense mass of small stunted trees, usually very bent. The canopy is only about 5 to 9 m high, though occasional trees reach 13 m. At lower altitudes, Fagaceae, Podocarpaceae and Myrtaceae are the dominant tree families. Fagaceae are largely replaced at higher elevations by Ericaceae and Guttiferae. At lower altitudes, common trees include *Lithocarpus hatusmae* and the conifers *Dacrydium beccarii* and *Phyllocladus hypophyllus*. At higher elevations, the conifers are joined by *Calophyllum garcinoides* and *Eugenia kinabaluense*. In the tree and shrub layer, there are many members of the family Ericaeae, including *Diplycosia*, *Rhododendron* and *Vaccinium*. Pitcher plants are conspicuous, including *Nepenthes muluensis* which is endemic to Mulu, i.e., is found nowhere else in the world.

Around the summit of Mulu, much of the vegetation was disturbed by establishment of a trigonometric survey point. Remaining vegetation is dense and shrubby, only 0.5 m to 3 m high, with a few trees reaching 5 m. The latter are mainly *Dacrydium beccarii* and *Leptospermum flavescens*. The species of plants are similar to the upper montane forest, with many members of the Ericaceae.

MELINAU LIMESTONE

On the steep, boulder-strewn scree slopes at lower altitudes, the lowland limestone scree forest is mainly open with few, widely-spaced trees. It is dominated by massive emergents, some of which

ALLUVIAL PLAIN

Forests on the alluvial plain are a complex array of alluvial and kerangas forests, with a small area of peat swamp forest.

The lowland alluvial forest itself is complex, due to considerable variations in soil. The most widespread type is that on the floodplain of the Melinau and Melinau Paku rivers. Here, the forest is relatively open, with an uneven canopy. The forest is not as tall as lowland MDF, with large emergents rising to heights of only 30 to 40 m. Maximum tree girths are generally only about 200 cm, though occasional belian (*Eusideroxylon zwagerii*) reach 250 cm. Common trees include *Dracontomelon dao, Octomeles sumatrana, Parashorea macrophylla, Pentaspadon motleyi, Pometia pinnata, Pterospermum subpeltatum, Shorea seminis* and, amongst the smaller trees, *Bhesa paniculata, Paranephelium sp.* and *Polyalthia hookeriana*.

Kerangas or tropical heath forest also tends to be variable, depending on soil type and drainage. The forest mainly comprises medium to small, pole-like trees with an even canopy. Few trees exceed 200 cm girth, and most are smaller. The understorey is dense, with an abundance of palms, pandans, pitcher plants and shrubs. *Shorea albida* is the most common tree, with other abundant species in different parts of the formation being *Calophyllum garcinioides, C. havilandii, Cotylelobium burkii, Gluta macrocarpa, Shorea scabrida, Tristania obovata, Agathis borneensis* and *Casuarina nobilis*. Where drainage is poor and shallow peat forms, common trees include Shorea albida, Dactylocladus stenostachys, Gluta beccarii, Lophopetalum rigidum and Payena sp.. In these areas, the pitcher plants Nepenthes bicalcarata and N. rafflesiana are abundant on the ground. On sloping margins of the alluvial terrace, dipterocarps are dominant, and tree species are similar to those of lowland MDF.

The peat swamp forest between the Terikan and Medalam rivers covers only about 180 ha in area. Even so, it shows the typical concentric zonation of forest types found in much larger peat swamp areas, probably due to a decline in fertility of the peat soils towards the middle of the formation. Four forest types are recognised, with more open, diverse forest, and a canopy height of about 32 m on the outside, making way for smaller, denser and less diverse vegetation toward the middle. In the very centre is a low, open forest, with few trees taller than 10 m.

SETAP SHALES IN MENTAWAI DRAINAGE

The lowland MDF here is variable. It is generally similar in structure to that on Gunung Mulu, although trees tend to be smaller, with canopy height generally less than 50 m. Moreover, tree species composition is very different. The dominant emergents are mostly *Shorea* species (*S. beccariana, S. maxwelliana, S. ovlais and S. virescens*. Other abundant trees include *Dryobalanops* *beccarii*, *Parashorea smythiesii* and *Elateriospermum tapos*. Of the smaller trees, those in the Ebenaceae and Myristicaceae families are frequent. Palms are rich and diverse below the trees, and the spiny palm *Oncosperma horridum* occurs on the slopes.

The extensive high terraces of this area are covered entirely with kerangas forest. Its structure and tree composition is somewhat different to that of the other kerangas forests in the Park. The uneven canopy is generally between 30 and 40 m high, and most of the trees have small girths. Common species here include *Casuarina nobilis*, *Dipterocarpus lowii*, *Gluta macrocarpa*, *Shorea acuta*, *S. ovata*, *S. venulosa*, *Ashtonia excelsa*, *Hopea vaccinifolia*, *Myristica lowiana*, *Santira laevigata* and *Whiteodendron moultonianum*. The wild sago palm grows on some of the terraces and ridges.

For a full list of plants recorded in the Park, see Anderson *et al.* (1982).

3.4 FAUNA

Gunung Mulu National Park has a rich diversity of animals[1]. About 70 species of mammals, 262 of birds, 50 of snakes and lizards, 63 frogs, 47 of fish and 281 of butterflies were recorded inside the Park during the 1978-79 Gunung Mulu Expedition; there are about 20,000 invertebrate species in the Park (Anderson *et al.*, 1982).

For a full list of animal species recorded in the Park up to 1982, see Anderson *et al.* (1982), and of the bird fauna, see Wells *al.* (undated); NPWO (undated).

[1] The scientific names of all animals mentioned in the text are listed in Appendix 2.

MAMMALS

When walking inside the Park, it is rare to have good views of large mammals. This is because most species occur at low densities, especially in some of the forest types. Moreover, a large amount of the Park is montane or kerangas forest, which is not good habitat for many larger mammals, so diversity is probably less than in equivalent areas of forest elsewhere (Bennett *et al.*, 1987).

The sun bear occurs in the Park, and its tracks have been recorded at high elevations on G. Mulu. Surprisingly, the clouded leopard has not been recorded, but at least eight other species of carnivore occur here, including the binturong, four smaller civets or musang (Malay, common palm, small-toothed palm and banded palm civets), otters (species unknown), yellow-throated marten and mongoose.

Of the more conspicuous large mammals, the Bornean gibbon occurs in the Park but has a limited distribution since it is not found in the alluvial habitats or limestone hills. How much this is due to the habitat being unsuitable, and how much to hunting, is not clear (Anderson *et al.*, 1982). The primate fauna is rich, with three species of langur (leaf monkey): red, Hose's and, somewhat surprisingly so far inland, the silvered. Even by 1980 the langurs were absent from some of the more accessible, alluvial areas of the Park, implying that, like the gibbons, they had been over-hunted. Both of Borneo's macaques occur in the Park: the long-tailed and pig-tailed, as do both of Borneo's small, nocturnal primates, the slow loris and western tarsier. Four of Mulu's primate species are endemic to Borneo, notably red and Hose's langurs, Bornean gibbon and western tarsier.

As would be expected, bearded pigs (babi hutan) are widespread throughout the park, although in relatively low numbers. All of the deer are also characteristically rare; species present are the mouse deer, barking deer (kijang) and sambar deer (rusa or payau). Although sambar deer still occur in the park, it is likely that their tracks in the entrance of Deer Cave were made decades ago.

Squirrel diversity in the Park is high, with different species occurring in different forest types and altitudes. Seven species occur in the lowlands, including two Bornean endemics: the large and beautiful tufted ground squirrel and, at the opposite end of the size scale, the mouse-sized plain pygmy squirrel. Other squirrels of the lowlands include Prevost's, plantain, horse-tailed, three-striped ground squirrel, and the nocturnal black flying squirrel. At higher altitudes, the squirrels are especially interesting since all four species are endemic only to Borneo: Kinabalu squirrel, Jentink's squirrel, Bornean mountain ground squirrel and Whitehead's pygmy squirrel. Other rodents include at least two species of porcupine (long-tailed and one unidentified) and at least seven of rats (Anderson *et al.*, 1982).

Other small mammals in the Park include the pungent-smelling moonrat, three species of treeshrew (mountain, painted and smooth-tailed treeshrews), and the nocturnal, gliding colugo or flying lemur.

By far the most conspicuous and famous mammals of Gunung Mulu National Park are the bats. Nocturnal and largely cave-roosting, Mulu's bats are one of the greatest wildlife spectaculars in the region as they emerge at dusk in their thousands from Deer Cave, swirling and eddying in the cave mouth before forming an undulating, moving band of bats flying away over the forest to find food up to 50 km away. The prolific Deer Cave bats are mostly wrinkle-lipped bats, although 16 species have been recorded in the Park. Some of these are cave roosters, others not. Of particular note are: (i) the grey fruit bat which is a montane species found only in Mulu, the Kelabit Highlands, plus the Crocker Range and Mount Kinabalu in Sabah; and (ii) two species of bat known only from the Mulu area in Sarawak, the lesser tailless roundleaf bat and the orange tube-nosed bat (Anderson *et al.*, 1982).

BIRDS

Bird diversity is high, and the Park contains many rare species which will attract specialist bird watchers to the area. The distribution of birds is not uniform, with most species being restricted to one or two habitats.

The richest bird fauna, assessed either by the number of species (about 200) or the density of birds, is in the low-lying alluvial forests of the river valleys (Wells *et al.*, undated). Less than half of this number of species are found in the kerangas/peat swamp forest areas, and the number of species declines further with increasing altitude. In mossy, upper montane forest, only about 27 species of birds are found. Some of these species have extremely limited distributions both within the Park, and also globally since some are only found on high mountains.

Of the most conspicuous birds, all eight of Sarawak's hornbill species have been recorded in the Park, including the helmeted with its cackling call, and the rhinoceros hornbill or kenyalang, Sarawak's State bird. Wreathed hornbills are also conspicuous because they are relatively abundant.

The raptors are another diverse group of larger birds, with 13 species of eagles, hawks and falcons present. Most visitors will see the specialised bat hawk which regularly hunts the bats emerging from Deer Cave at dusk. The peregrine falcon is present in this area, and apparently nests on the cliffs around deer cave (Anderson *et al.*, 1982). Also present in the Park is the rare Kinabalu serpent-eagle, which is only known from here, G. Murud, G. Kinabalu and the montane ridges along the Sarawak/Brunei border (Davison, 1992). Other raptors in the park include seven species of owl.

Pheasants and partridges are also well represented, with eight of Borneo's 12 forest species here: red-breasted partridge, black wood partridge, crested wood partridge, crimson-headed wood partridge, crested and crestless fireback pheasants, the increasingly endangered Bulwer's pheasant with its spectacular blue wattles, and the great argus pheasant, whose haunting calls penetrate the Park's forests at intervals through the day and night.

Not surprisingly, water birds are less conspicuous here. The oriental darter has been recorded. This is now highly endangered in Sarawak, and has declined dramatically through much of its range (Bennett, 1992), but it is unlikely that the population in the Park is large enough to be viable (Anderson *et al.*, 1982). Another bird becoming extremely rare elsewhere which has been recorded in the Park is the Storm's stork; again, numbers here are probably very low. The tiger bittern is present, and the most conspicuous water birds are the little green heron, common sandpiper as it wags its tail on the river beaches, and three species of riverine kingfisher: black-capped, stork-billed and blue-eared kingfishers. These can sometimes be seen as flashes of bright blue along the rivers and riverbanks during boat journeys. A further three kingfishers occur in the forests of the Park: banded, chestnut-collared and rufous-backed kingfishers.

Birds which are rarely seen but whose calls are conspicuous in the sounds of the forest are the barbets. All nine Bornean species have been recorded in the Park, each occupying a different forest type or altitudinal range. When climbing the mountains, it is possible to distinguish the changes in species from the different calls during the climb. The drumming of the four species of woodpecker as they drill into trees is also a common sound within the Park.

Sixteen species of cuckoos, five malcohas and the extremely rare ground-cuckoo occur in the Park, and all six of Borneo's trogons are present. The largest of these is the superb Whitehead's trogon which is endemic to Borneo, and frequents lower montane forest. Swifts and swiftlets are a conspicuous part of the bird fauna, especially as they swoop across rivers and clearings to catch insects. The brown-rumped (edible-nest) swiftlet has been seen, but no nesting colony found.

Of the many small passerine birds, the black-and-red broadbill builds its precarious-looking nests overhanging rivers. The 21 species of bulbuls are largely found in the lowlands, with only four species (black-and-white, pale-faced, ochraceous and ashy) being found above 1600 m a.s.l.. Of the remaining passerines, the babblers, flycatchers, sunbirds, flowerpeckers, starlings, thrushes, white-eyes, drongos and crows form diverse assemblages, separated by habitat and behaviour. Finally, the bamboo munia is endemic to Borneo and known only from the montane bamboo forests high on Mulu and Kinabalu; few people have ever seen this rare bird alive (Anderson *et al.*, 1982).

REPTILES AND AMPHIBIANS

Snakes are shy animals, and not noticed by most people, so current lists are undoubtedly incomplete. The reticulated python is present, as well as 24 smaller species of snake. Of particular note is the cave racer which occurs in several of the caves where it feeds on bats and swiftlets. Two burrowing snakes also occur in the park: the reed snakes (*Calamaria borneensis* and *C. melanota*). Of the more conspicuous, diurnal snakes in the Park are the colourful bronze-back and keel-bellied whip snake.

There are two families of poisonous snakes, the Elapidae (coral snakes and cobras) and Viperidae (vipers). The former is represented by three species, the cobra (either black or king) and the brightly-coloured red-headed krait and banded coral snake. Both of these twist and coil when disturbed, showing off their bright colours as a warning. There are three pit vipers in the Park, which often rest openly on the ground or on the branches of low trees. They are generally sluggish, and will not move unless severely provoked.

Twenty-three species of lizards have been recorded in the Park. Most conspicuous to visitors are the skinks and agamids which are active by day. Skinks mainly live on the ground, and are often seen basking in the sun. Agamids are mainly arboreal. They include the flying lizards, and the four species seem to occur, at least partly, at different altitudes. The seven gecko species are largely nocturnal; at least two of them were apparently newly described by the 1978-79 expedition, and are probably endemic to the Park (Anderson *et al.*, 1982).

The amphibian fauna is especially diverse in the Park. Some 75 species of frogs and toads have been recorded, representing two-thirds of all known species of Borneo. Six of the montane species are known only from here and G. Kinabalu (Anderson *et al.*, 1982). The most diverse groups are the true frogs (*Rana spp.*) (at least 14 species) and tree frogs (*Rhacophorus*) (10 species). Most widespread is the frog *Rana kuhli*, which is found in fast and slow streams, kerangas forest, and right up to ridge tops at 1750 m a.s.l.. Most other species have far more restricted distributions, including one (*Philautus sp.*) which apparently breeds in the fluid of pitcher plants. Other notable species are members of the *Rana macrodon* group, which are the largest frogs in the world and are heavily hunted for food, and Wallace's flying frog, which can glide through the air, supported by expanded flaps of skin between its toes and along its sides.

FISH

Few studies have been done on the Park's fish, yet 52 different species have been recorded. The Park is one of the very few areas of Sarawak where the full catchments of river headwaters are protected, so for the many species of fish which are vulnerable to disturbance, it is of enormous conservation importance. Thus, it is imperative to protect them from over-fishing, since the rivers of the Park can act as perhaps the only areas remaining in Sarawak where the sensitive species can breed. From there, they can act as breeding refuges from which fish can move out to areas of the Tutoh and Baram downstream, where fish are so important in the diet of many people.

INVERTEBRATES

Many studies have been done on the invertebrate fauna of the Park. Of particular note are the cave specialists such as the eyeless crab and the cave cockroach which scavenge on nesting debris and the carcasses of swiftlets and bats which fall into cave pools and the cave floor (Chapman, 1982).

Full details of the invertebrate studies, including those on the butterflies and moths, are given in Jermy and Kavanagh (1982).

3.5 ASSESSMENT

The key features which are of immediate importance for Park managers are the following:

The steepness of the mountain-sides, combined with high rainfall and thin soils, leads to risks of severe erosion or even major landslides if the vegetation is damaged. This will affect plans for new trails or for the upgrading of existing trails.

Many of the formations in the caves (stalactites, stalagmites, etc) are extremely fragile and all are irreparable. The first criterion for development and management of the caves must be the prevention of damage.

Many of the cave animals are known only from Mulu and sometimes only from a single cave in Mulu: this includes the blind cave fish so far only found in Lagan's Cave. In a few cases, only one specimen of a species has ever been seen. Animals which are so rare and localised can easily be wiped out. Hence the need to control access to caves and to see that disturbance is minimised.

The Park contains a wide range of different vegetation types, each occupying a small area. Thus, disturbance to just one area could wipe out an entire vegetation type and species array for the whole Park.

The lowland mixed dipterocarp forest is the single most diverse forest type in Mulu; it occurs in the most accessible regions of the Park (the lower slopes of Gg Mulu); and it is the most vulnerable to disturbance and encroachment. Total protection should be a management priority.

Some plants are extremely rare and endemic to the Park: they are found nowhere else in the world. Some are restricted to one or two spots in the Park, so that even localised disturbance could lead to extinction. Furthermore, they are of interest to collectors. All efforts will be made to protect them, especially the pitcher plants, orchids and palms.

Fire has destroyed some areas of vegetation on Gg Api in the past, and has permanently affected the vegetation. The general view that fire in undisturbed tropical forest is not a problem clearly does not apply to the limestone forest. Efforts are needed to prevent fires in future, including banning fires by tourists.

The specialised vegetation on the summit and the crests of the ridges is very fragile and limited to a small area. A large portion has already been damaged or destroyed in erecting a survey station, clearing helipads and trails, and building an overnight shelter. This habitat supports some highly specialised montane animals, and its conservation value in protecting those is inestimable. No further development should take place in the summit area, at least until the long-term effects of disturbance can be assessed.

The lowland forests are vital to many of the Park´s animals. By far the majority of the animals occur, and reach their highest densities in the lowland forests. Reproductive success is also greater in the lowlands for birds at least, and almost certainly for the larger mammals too. It is likely that the lowland areas act as breeding reservoirs for animals, thereby maintaining populations in the less productive habitats of the Park. The lowlands are by far the most vulnerable parts of the Park, both due to edge effects from clearance round the park boundaries, over-hunting, over-disturbance from tourism, and encroachment. Effective protection and management of the lowland forests is vital for the survival of many animals.

4.2.1 Conservation Zone

The zone does not allow any action which would cause the alteration or destruction of existing natural resources; no public access or trails but only limited scientific research may be permitted.

4.2.2 Natural Zone (low intensity usage)

Minimal human intervention: some public access allowed; trails to be maintained but signposting kept to a minimum; structures limited to simple overnight shelters;

4.2.3 Intensive Use Zone

Educational and recreational activities shall be highly promoted in order to divert people from the conservation zone; structures include hard trails (concrete or boardwalk), signs, picnic areas, shelters, toilets.

The areas near the entrances to Deer and Lang's Caves and Cave of the Winds, and around the Clearwater Spring come in this category.

In addition, this zone contains all major buildings, staff and visitor accommodation, office, interpretation centre, stores, etc. Park HQ and the Mentawai RS sites are included.

4.2.4 Traditional use zone

As for the Conservation Zone but subject to hunting, fishing and gathering in accordance with the provisions of the Proclamation (see Section 4.1.1).

4.3 VISITOR USE AND RECREATION

Gunung Mulu National Park offers a wide range of recreation including a rigorous climb to the mountain summit, natural walk through the tropical rain forest and visit to the world s largest cave, it is all available in Gunung Mulu National Park.

4.3.1 FACILITIES

4.3.1.1 Transport and utilities

The Park can be reached from Miri either by boat via Marudi and Long Terawan or by air to the Mulu airstrip which has just outside the Park. Helicopter flight can also be made to Park HQ, Deer Cave and overnight shelters. Transport within the Park is by boat, canoe and plankwalk.

4.3.1.5 Show Caves

Four caves with aesthetically unique features within easy access from Park HQ have been developed as show caves: Deer Cave, Lang's Cave, Cave of the Winds and Clearwater Cave. They are fitted with concrete and belian footpaths and with electric lighting for paths and features. The electrical systems are not waterproof and they breakdown frequently.

Day shelters and a toilet block have been constructed near the entrance to Clearwater cave. In the Deer Cave area, toilets are available at the Bat Observatory.

4.3.1.6 Canteen

A canteen on the Park HQ site provides meals and also sells tinned foods and other supplier.

4.3.2 VISITOR PROFILE AND RECREATION PATTERN

4.3.2.1 Annual Visitation

Figures for visitor arrivals are shown in Table 2.

From October 1991 to September 1992, the Park had 11,487 visitors. Assuming that visitors stay for two days at the Park on average, this represents an average of 64 visitors in the Park each day. However, visitation is highly seasonal, being most active in June, July and August: in July 1992, the Park received more than 2500 visitors, averaging more than 160 visitors in the Park per day.

The figures for 1990 were 5,766 visitors or on average 32 visitors per day.

In a period of just over one year, the numbers visiting the Park have more than doubled.

4.3.2.2 Total Revenue

Revenue collected from October 1991 to September 1992 was RM42,336. This includes all sub-camp and accommodation fees. The total revenue from guide fees in the same period is approximately RM50,000, representing a grand total of around RM100,000. This is regligible as compared with park expenditure. (see Appendix 6)

Table 2: VISITORS TO GUNUNG MULU NATIONAL PARK

	1986	1987	1988	1989	1990	1991	1992
January	68	80	125	80	211	410	313
February	23	130	150	190	238	520	675
March	42	135	100	200	307	486	374
April	98	160	175	190	564	608	673
May	46	330	290	435	493	635	1017
June	80	130	585	430	704	685	1627
July	75	275	320	605	806	945	2476
August	39	130	360	390	579	1518	1359
September	50	280	230	200	398	470	823
October	29	90	255	270	386	626	792
November	39	25	140	240	641	661	1086
December	29	100	130	136	439	463	
TOTALS :	618	1865	2860	3366	5766	8027	

4.3.2.3 Visitor Profile

From October 1991 to September 1992, 6122 foreigners and 5365 Malaysians visited the Park.

For the year 1990, the figures were 3176 foreigners (55% of the total) and 2590 Malaysians (45%). The percentage of total visitors to the Park who are foreigners is fairly constant.

4.3.2.4 Travel Patterns

Since the opening of the airport, it is estimated that 30% of visitors arrive by air. The most popular route into the Park is still by express boat from Miri via Marudi to Long Terawan, then by longboat to the Park. This takes a full day compared to the 35 minute flight from Miri to Mulu and the costs are approximately the same. Some visitors arrive by boat and leave by air or vice versa.

A very small percentage of visitors from Limbang enter the Park through the Mentawai Ranger Post. They proceed to the Melinau Gorge Hut and Pinnacles, before arrive Park HQ. Later, they depart Mulu using Marudi route or fly to Miri.

More flights from Marudi and Limbang are planned. This will affect the total numbers of visitors arriving by air and generally increase the number of visitors per year.

4.3.2.5 Recreation Patterns and Activities

From October 1991 to September 1992:

9578 people visited the show caves only;
1182 people visited the Pinnacles;
250 people climbed to the Summit;
95 people did adventure caving;
382 people official visitors on special duty to the Park.

Almost everyone visiting the Park visits the Mulu Show Caves. This includes all visitors who also climb the Pinnacles, the Summit and go adventure caving.

The general increase in the number of visitors is reflected in the increase of the number of visitors climbing the Pinnacles and the Summit.

Adventure caving is a growing activity. Many tourists come back to Mulu for a second time and visit the wild caves. Sarawak Chamber is becoming a famous destination but must be limited to the fit and competent parties. Adventure caving is popular in other national parks in the world, and Mulu is no exception.

4.4 LAND USE PATTERNS OF LOCAL COMMUNITIES

4.4.1 Nomadic and semi-settled Penan

About 4 families of Penan still practise a nomadic way of life in an area which includes the Ubung catchment in the south-east corner of the Park. Many of the Penan of Long Iman and especially Batu Bungan do not grow sufficient food crops and spend a large part of the year hunting and gathering in the traditional fashion in the Park.

It is impossible for Park staff to control this activity, and to ensure that it remains within the terms of the gazetted privileges. It is certain that Penan hunt many species for food, including protected and totally protected species.

4.4.2 Longhouse communities

The extent to which privileges to hunt, fish and gather in the Park is not monitored. Because of difficult access, it is unlikely that the Long Seridan people make much use of their privileges in the Ubung catchment. The extent of legal use of the Mentawai privilege area is not clear.

The area in the south-west, however, appears to be heavily used by Berawan from Long Terawan and Penan from Long Iman; this is associated with the high population levels around the Melinau river, which is due in turn to the employment opportunities offered by the Park. Levels of exploitation are certainly higher than was envisaged when the privileges were gazetted and cannot be sustainable.

Privileges holders may also hunt, fish and gather for commercial purposes, in particular to provide wild meat, fish or forest plants (eg. palm hearts) for visitors to the Park. When the Park first opened, tour operators encouraged the Penan to bring wild meat to groups at the overnight shelters, and Park staff had to intervene to stop this. The Park Proclamation does not limit harvesting to items for the privilege-holder's own consumption.

4.4.3 Illegal activities

4.4.3.1 Abuse of privileges

Those with privileges within the Park may not respect the limitations to those privileges; in particular, they may hunt animals other than pig and deer. No information is available on this.

There has been a case of tour operator's staff fishing at the Melinau Gorge (where no privileges exist) to feed clients and that operator tells prospective clients of the wonderful fresh fish available there.

4.4.3.2 Local people without privileges

Some of the people claiming privileges may not be entitled to them; there is no method for Park Rangers to verify a hunter's claim to be an inhabitant of one of the privileged longhouses.

Traces of trail-cutting and remains of hunting and fishing camps have been seen in the Terikan and Medalam catchments and in the Melinau Gorge area: no groups have privileges in this area.

There is evidence of forest produce extraction, hunting and fishing in areas adjacent to logging camps.

4.4.3.3 Illegal logging

There is evidence of illegal timber extraction (waterlogs) in the north within easy reach of the Terikan, Mentawai and Medalam Rivers. To the east, in the Ubong catchment, encroachment by a timber licensee was detected in 1991.

4.4.3.4 Illegal cultivation

On a few occasions local people have indicated their intention to clear and farm within the Park: traditionally this is done by putting a marker on the river bank. Prompt action by Park staff has prevented them putting this into effect, so there is no evidence of illegal cultivation in the Park.

4.4.3.5 VIP visitors

There is a rumour among local people that senior government officials and politicians hunt and fish in the Park and this is used to justify their own poaching. The basis of the rumour is probably that senior people staying at Park HQ have hunted and fished outside the Park, sometimes fishing within a few metres of the Park boundary. There is no evidence of illegal hunting or fishing by VIP visitors.

4.5 LAND USE FOR MANAGEMENT PURPOSES

4.5.1 Staff accommodation

At Park HQ, 22 units of labourers' barracks and 4 units of staff housing are available. Four units of barracks have been constructed at the Mentawai Ranger Post, but two are temporarily used as office/store and visitor accommodation.

4.5.2 Other buildings

The main Park Office is in the same building as the Visitor Centre. A general store and boat shed are also on the HQ site. Generator houses are situated at Park HQ, Mentawai Ranger Post, Deer Cave, Cave of the Winds and Clearwater Cave.

protect its wildlife.

Preventive measures are:

- education of wildlife rangers and Police about what animals are protected and totally protected, and how to recognise them and their products;
- widespread publicity material about protected and totally protected species, and penalties for infringing the law. This should be provided by tour companies, at the entrance to the Park, and in all hostels, lodges and hotels around the Park;
- frequent patrols by wildlife rangers and Police to potential points of sale;
- confiscation of all illegal wildlife products;
- prosecution of traders under the Wild Life Protection Ordinance 1990;
- confiscation of wildlife products from tour guides and tourists, and prosecution of serious and repeated offenders.

6.5.3 CONTROL OF FISHING

The Park is extremely important in conserving rare fish species. It is also a vital reservoir of fish for consumption by local people all along the Baram and Tutoh rivers (Section 4.1.1). Although the main rivers which form the Park boundaries are outside the Park, NPWO should discourage fishing by visitors.

It is illegal for any outsiders to fish inside the Park. No exceptions should be made under any circumstances, including visits by VIPs. This is because:
(1) it is illegal;
(2) it presents visitors with the wrong image of the Park and conservation. Such visits should be used to emphasise the value and meaning of conservation. Conservation of endangered fish and of fish stocks is part of this message, and allowing them to infringe regulations and fish inside the Park undermines that message;
(3) it sends the wrong image to local and foreign visitors if Park authorities condone illegal fishing.

Preventive measures are:
- Regular patrol by Park Rangers to areas prone to illegal fishing.
- Offenders will be prosecuted.

6.5.4 CONTROL OF PLANT COLLECTION

Many of the plant species in the Park are extremely rare, both within the Park, and worldwide (Section 3.3). These include the pitcher plants and many of the orchid species (Section XX; Kiew, 1991). Many of these are disappearing from the main tourist by the local people who know the Park well. This means that enforcement by NPWO staff cannot be completely effective without the help of local communities.

5.3 MANAGEMENT ZONES

The existing zones will remain unchanged. (See section 4.2)

5.4 CARRYING CAPACITY

The carrying capacity of a recreational site may be determined by
- physical factors - the facilities are saturated,
- environmental factors - the natural resource is degraded,
- perceptual or psychological factors - visitor enjoyment is reduced.

Sometimes the limiting factor can be manipulated (eg. investing in additional facilities); sometimes it cannot (eg. disturbance to wildlife by the presence of humans). The carrying capacity may be expressed as a number of people per day or per year, or as a limiting criterion (eg. patches of bare vegetation).

5.4.1 Show Caves

The show caves are extremely fragile, and necessitate adequate protection of formations with physical paths and barriers plus supervision by guides. At present, each show cave can handle 3 groups of 10 visitors per hour, 240 in an 8 hr day.

With additional Park Guides this could be increased to 6 groups of 20 visitors (with 2 Guides each) per hour, or 960 per day, except for Lang's Cave which is physically too small to take large numbers.

With the construction of further paths in Deer Cave to complete the loop, and paths in Clearwater to utilize the Link Cave entrance, one way traffic could be imposed in these caves and the carrying capacity increased to 1920 per day.

5.4.2 Forest trails

The Summit trail is very steep and subject to localised erosion, even though the number of visitors using it is low. For ecological reasons, numbers should be limited to 10 per day: capacity of the existing overnight shelters should not be increased, though a third shelter mid-way between them should be constructed; use of the trail will then be limited to those who have booked shelters. Ten people per day corresponds to a maximum of 3650 per year, far too many for the existing trail; Parks staff must monitor erosion and, if it cannot be prevented by improving the trail, access to the mountain has to be restricted.

The Pinnacles trail is less subject to erosion over most of its length, and trail improvements have already been carried out at vulnerable places. Access should be limited to about 30 per day, with the same requirement for staff to monitor erosion, improve the trail in affected areas or to reduce usage. Since the Pinnacle climb normally involves two nights at the Melinau Gorge shelter, its capacity should be limited to 60 people per night.

5.5 PARK EXTENSIONS

The major objectives of Park management include the protection of watersheds of the Medalam and the Tutoh tributaries, whole limestone massifs and flora and fauna. In several places, main rivers form the boundary of the Park, so that only one bank is within the Park. Clearly, effective management of the water resource is impossible in these circumstances. Beside for effective protection of natural resources the Park has to be as large as possible. Therefore, three extensions of the Park have been proposed:

5.5.1 Medalam Extension

This covers the area of the present Medalam Protected Forest: approximately 35,000 acres (14,170 ha. This extension would -

- permit effective management of the Medalam water resource;
- bring the whole outcrop of Melinau Limestone, with its caves and unique flora, within the Park;
- increase the area of alluvial forest in the Park, since the existing area is very small and is subject to visitor pressure;
- increase size of the core area, thereby increasing the chances of survival of many species in the Park;
- improve anti-poaching measures in the whole Medalam catchment;
- provide recreational facilities in the Limbang Division;
- provide an opportunity to study forest regeneration after logging.

5.5.2 Ubung Extension

This covers the eastern half of the catchment of the Sungai Ubung: approximately 40,000 acres (16,194 ha). This extension would -

- permit effective management of the Ubung water resource;
- increase size of the core area, thereby increasing the chances of survival of many species in the Park;
- improve anti-poaching measures in the whole Ubung catchment;
- provide recreational facilities near the line of the proposed Long Seridan to Long Lama highway; and
- provide an opportunity to study forest regeneration after logging.

5.5.3 Lutut Extension

This covers a small area in the headwaters of the Sungai Lutut between the Lutut and the Brunei border; it corresponds to three coups: approximately 2501 acres (1012 ha). This extension would -

- permit effective management of the Lutut water resource, which provides water for the tourist facilities on the Melinau;
- improve anti-poaching measures in the whole Ubung catchment;
- increase the interface with the Nature Reserve in Brunei.

See Appendix 3 for further details of the proposals.

5.6 WILDLIFE MANAGEMENT STRATEGIES

5.6.1 Minimising disturbance

In order to maintain a truly representative sample of the Sarawak forest ecosystem, the central wildlife management strategy must be to minimise disturbance to the wildlife in the Park.

There is no evidence that active manipulation of wildlife populations in Mulu is necessary to maintain the ecosystem.

5.6.2 Introduction animals

On occasion, there are suggestions that animals should be introduced (or reintroduced) to the Park, or that animals should be kept in cages or enclosures for visitors to see. However, there is a grave risk that this will result in damage or even destruction of natural animal populations in the Park. A brief discussion of the reasons for this are in Appendix 4.

Thus, for the present and in the near future animals will not be released in the Park nor will animals be kept in cages or enclosures within the Park.

CHAPTER 6 MANAGEMENT PROGRAMMES

6.1 COMMUNITY DEVELOPMENT

NPWO realises that rural people who live near the park have a greater impact on Mulu than any other factor. It is with this knowledge that the first management plan recommended that Penans be considered for "gainful employment in the park as Forest Guards, guides for tourists.....".

Through community development, the Department intends to secure greater protection and conservation for the park. The Department's stategy of combining conservation and development has been greatly helped by the opening of the Penan Service Centre near the park. Besides Penans, the other local villagers have also benefitted from the community development and conservation concept through the encouragement of local businesses like river transport and lodges.

6.1.1 Community Development Programmes

They include:

i) Public Education and Extension Service:
To promote understanding and to encourage participation of the local community in the protection and conservation of the park and to encourage local business.

Talks briefing and short course on related field of conservation, protection and local business directed at local communities shall be carried out by the Environmental Education Unit of the NPWO.

ii) Land Disputes, Physical Development and Agriculture:
The urgent task is to work closely with the relevant authorities to settle. Land dispute outside the Park boundary. Besides, programme will be drawn to encourage alternative source of meat and other daily needs through animal husbandry and agriculture. The Park administration will help in ensuring orderly physical development. For example, there is a need to plan tourist accommodation facilities.

Even though the State Government has assigned to one Senior Administrative Officer a duty to oversee all areas relating to land disputes, physical development and agriculture outside the Park. The cooperation of all government agencies is very important. NPWO will prepare two progress reports yearly.

6.2. PARK ADMINISTRATION

6.2.1 Staffing

The Park's organizational structure has two major components: Park HQ and Ranger Posts. Park HQ isthe administrative centre of Gunung Mulu National Park and includes the office of the Officer-In-Charge (Deputy Park Warden) and five administrative sections:

- development and constitution
- protection
- administration
- visitor management
- maintenance.

Each section is headed by a Park Ranger.

Each section is short of trained manpower. The development section is headed by a contract officer. The protection, visitor management and maintenance sections are headed by only one Park Ranger, while the administrative section is headed by one sub-professional staff.

When one or two officers go on leave or on travelling duty, the Park administration problem would become acute. This is particularly serious in the maintenance and visitor management sections which require knowledgeable persons. For instance when Park generators break down. The Park has to request Public Work Department to send a mechanic from Marudi or Miri. It may take up to five days to have the machinery repaired.

In addition, the Ranger Post at Mentawai is headed by a Park Ranger. The Park Ranger has to come from Miri and other National Parks on rotational basis. He is assisted by four daily-paid labourers to carry out law enforcement, Park maintenance and visitor management.

6.2.1.1 Headquarters Personnel

Park HQ shall be staffed by:

i) One university graduate as the Officer-in-charge. The Forest Department has requested for the post to be created.

   At present, there is none. This is to ensure that Park Management is carried out professionaly.

   A graduate engaged on contract service by the Forest Department will be posted to Gunung Mulu National Park as Officer-in-charge.

ii) One Diploma holder as assistant to the Officer-in-charge. At present, there is one post for a diploma holder but is now vacant.

   A Diploma holder from other station will be deployed to

Mulu to assist the Officer-in-charge as and when needs arise. If a graduate is sent to Mulu as O.I.C. there is no urgency to fill this vacant post.

iii) Senior Park Ranger as section-in-charge. There are five sections. One post has been approved but is still vacant. The Forest Department has requested for another post to be created.

The vacant post will be filled through staff transfer from other divisions of the Forest Department. Actually it could be filled through promotion exercise.

iv) Park Rangers. Preferably two Park Rangers to assist the senior Park Ranger of each administrative section. Three of the four posts available filled. The Forest Department has sought permission for another post to be created.

The vacant post will be filled through staff recruitment and staff transfer from other areas.

v) Park Guide. There are 18 park guides employed on a daily-paid basis. The Park guide post is not available. The number of Park guides will depend on the increase of the visitors.

The Forest Department will seek permission to create permanent as well as contract Park guides post.

vi) Other staff include:-

Boat Driver	-	Three posts are required. One post has been filled by a permanent staff and the others are to be filled by daily paid drivers.
Foreman	-	Two posts are required. Currently the job is handled by a permanent labourer.
Housekeeper	-	Three posts are needed. At present, It is handled by five daily paid staff.
Plant Operator	-	Four posts are required. Currently it is handled by four daily paid operators. Three for the show caves and one for Park HQ.
General Helper	-	Five posts are required. At present, daily paid labourers are engaged as general helpers.

Clerk/Typist	-	One post is required. Presently, it is handled by a daily paid "cook".
Receptionist	-	One post is required. No post is available at the present time.

The Forest Department will seek approval to engage the various staff on contract or daily paid basis until the post is created and filled. In addition, privatisation of certain Park services have to be given due consideration. Privatisation could minimise government expenditure, reduce staff, shortage problem and improve efficiency of Park Management.

6.2.1.2 Ranger Post Personnel

Ranger Post at Mentawai shall be staffed by:

i) One Senior Park Ranger. He is the O.I.C. of the Ranger Station. At present, the post is not available.

ii) Park Ranger. Three Park Rangers are required. There is presently no Park Ranger post at Mentawai.

iii) Other Park staff include boat driver, plant operator, housekeeper, care taker etc. The posts need to be created.

The Forest Department will seek permission to create the posts for the Ranger post. As a stop-gap measure, a Park Ranger from other station will be transfered to the Ranger post. For others, however, daily paid labourers will be recruited to work as plant operator, house keeper, care taker etc., as and when required.

6.2.2. Training

Training is a very important component of Park management. Without capable and competent staff, it is difficult to realise the many management objectives. Perminent and semi-perminent Park staff in particular have to be given inservice training on Nature Conservation and Wildlife Management. Effort has also to be made yearly to release at least one officer to attend Nature Conservation and Wildlife Management course.

Other short in-house training must be given to Park staff on relivent areas. These include first aid and safety, caving technique, conservation education, park rules and regulation, communication and public relation courses. Short courses could be conducted by Education and Extension Unit of the Forest Department, Tourist Promotion Board (TPB), Red Crescent Society etc.

6.3 LAW ENFORCEMENT

It is the Park officers' basic responsibility to protect the Park against illegal encroachment and poaching of timber, wildlife and forest products. The results of uncontrolled extraction of forest produce, hunting and fishing by local inhabitants with the privilege to do so, together with poaching by people without privileges could be disastrous. It could led to a very sever depletion of wildlife resources.

6.3.1 Control of entry to Park

The visitor permit system has already established. However, permits may be issued at a number of offices and coordination is essential if we were to limit numbers and avoid overcrowding.

Effort has to be made to monitor the functioning of the booking system for visitors and make the necessary changes to prevent overbooking.

At present, tour operators' staff (guides, porters, boatmen) are allowed to enter the Park without formality. Since these people can greatly help or hinder the work of Parks staff, some form of control and influence is desirable.

A limited number of Entry Permits will be issued each month to the staff of registered tour operators. The criteria for approval are set out in Appendix 5.

Park staff have no way of checking whether the local people found in the Park are indeed entitled to privileges. To resolve this problem privilege permits will be issued to all those entitled to the privileges of the Park.

6.3.2 Role of Park Guides

The primary role of Park Guides is to ensure the protection of Park resources. Their main effort will be to educate and persuade people of the need to protect the Park, but they should have the authority to enforce the National Parks Ordinance as Park Officers.

Park guides will be empowered under section 14 of the National Parks and Nature Reserves Ordinance to enforce the Ordinance in the same way as Park Rangers.

A training programme will be instituted to ensure that all Guides recruited are able to carry out their duties effectively (see 6.2.2).

6.3.3 Boundary Patrols

At present, patrols are mainly conducted by Rangers with the assistance of daily paid labourers. They are carried out irregularly, as and when there is available manpower. Priority is given to areas which are prone to encroachment.

The Park boundary is over 130 km long, and includes some very difficult terrain. The Park is surrounded by human activities including farming and logging. Illegal extraction of timber trees along major rivers is very difficult to detect and is usually discovered months after the offender has finished and cannot be traced.

Aerial surveys by helicopter covering the total length of the Park boundary will be carried out once every two months. A small aircraft, capable of flying low and landing in small areas will be used.

Small autonomous teams comprising two or three Park personnel (daily paid labourers) who are familiar with the Park boundary will be deployed once in four months to walk along Park boundaries, especially in areas adjacent to commercial logging.

Where there are reports or evidence of illegal encroachment, a larger team comprising Park Rangers and enforcement staff (daily paid labourers) will be deployed immediately to the suspected area. Helicopter support will be arranged if necessary.

6.3.4 Boundary Marking and Maintenance

Park boundaries are marked by one foot square aluminium plates marked "N.P." nailed to trees at intervals of 100 m along the cutline and at critical points where the boundary changes direction and by red paint on trees about four feet above the ground. Unless the boundary follows a riverbank, a rentis is cut to a width of ten feet, with concrete pile markers placed at the beginning of each cut or mountain ridges line.

Boundaries were last maintained (rentises cleared, plates and paint renewed) as follows (Figure 10):

A. Cut line from Brunei border to Ng Mentawai: 1987
B. Sungai Medalam from Ng Mentawai upstream: 1989.
C. The watershed between the Seridan and Melinau Rivers: 1989
D. Sungai Ubong except for the upper reaches: 1990
E. Sungai Tutoh: Boundary plates placed at strategic places; no painting.
F. Cut lines from Sg Tutoh to the Melinau Paku River: 1989
G. Melinau River from Lg Melinau Paku to Lg Lutut: 1989
H. Lutut River: 1990

No marking or maintenace has been done by the Forest Department along the Brunei border.

The cut lines (A and F above) will be cleared and remarked.

Boundaries following navigable rivers (B. Medalam up to the Medalam Gorge, E. Tutoh up to Batu Molong Rapid, G. Melinau) will be checked and remarked.

Boundaries along the Tutoh River and Lutut River (E and H above) will be brought up to standard.

6.4 VISITOR USE AND INTERPRETATION

6.4.1 PARK FACILITIES

Park facilities are required in areas where there is high usage by visitors. Five such areas have been identified. These are:

a. Park Headquarters
b. Mentawai Ranger Station
c. Melinau Gorge
d. Show Caves
e. Sub-camps

6.4.1.1 Park Headquarters

The existing park headquarters at Sg. Melinau serves as the main entry point and administrative centre for the park. Currently, it is the most developed part of the park in terms of visitor and staff accommodation facilities. The existing resthouse and annexe, chalets and hostels at the park headquarters have a capacity to accommodate a total number of 150 persons at any one time. The private hotel (currently under construction) and lodges outside the park have a capacity to accommodate approximately 1000 visitors. In view of this, it is proposed that no more visitor accommodation facilities should be built at the park headquarters area apart from those already committed as this can be adequately provided for by private operators outside the park.

The major developments at the headquarters area relate to improvements to existing infrastructure, including accommodation facilities for the staff manning the station. A summary of these is as follows:

1. Path and Compound Lighting
2. 2 units Chalets (tender awarded)
3. Water Treatment Plant
4. 2 x 6 Door Staff Barrack
5. Retaining Wall
6. Public Toilet
7. Multi Purpose Hall
8. Concrete Footpath and Plankwalk to Staff Housing Area
9. Plankwalk and Trail to Clearwater Cave
10. Shelters, Benches and Toilets along Nature Trail (Headquarters - Pulau Bangan - Batu Bungan - Headquarters)
11. Shelters along Deer Cave Plankwalk
12. 1 incinerator

6.4.1.2 Mentawai Ranger Station

The Mentawai Ranger Station serves as the main entry point at the northern park boundary. It serves visitors coming in from the Brunei and Limbang side and because of its strategic location, it also serves as the main station to check illegal encroachment and poaching inside the Park. Currently, the station has only a 4 door barrack and the following facilities are required in order for the station to be fully operational:

1. 1 x 4 Door Staff Barrack
2. 1 unit Administration Block (including Information Centre and Store)
3. 1 unit Hostel (to accommodate 40 persons)
4. 2 units Staff Quarters
5. Plankwalk and Shelters
6. Pontoon Jetty
7. 1 Incinerator
8. Utilities (Power & Water Supply)

6.4.1.3 Melinau Gorge

The Melinau Gorge, also known as Camp 5 serves as the main transit point for visitors going to the limestone pinnacles and those travelling from the Mentawai entry point to the park headquarters at Sg. Melinau. Currently, an open-style hostel with a capacity of 30 persons is provided for visitors. In view of the popularity of the pinnacles as an attraction, and the expected increased number of visitors coming in from the Mentawai side, further improvement to accommodation, cooking and toilet facilities is required. The followings are proposed for development:

a. 1 unit Hostel/Transit Camp
b. 1 no Suspension Bridge (across Sg. Melinau)
c. Renovation to Existing Hostel
d. 1 Incinerator

6.4.1.4 Show Caves

The Park has developed 4 main caves as 'Show Caves' for visitors. These are Deer, Lang, Wind and Clearwater Caves. Plankwalks, concrete footpaths and installation of lighting have been developed inside these caves. However, persistent problems have been encountered with regards to the electrical system in all the caves due to use of inappropriate electrical accessories and ports, including generators which do not have sufficient voltage capacity. The following works are proposed:

a. Public Toilet, Picnic Shelters, Benches, Plankwalk & Mini Dam at Deer/Lang Cave
b. 2 nos 30 kw Generators to Deer, Lang, Wind & CLearwater Caves (total: 6 nos) c/w rewiring
c. Bridge at Clearwater Cave.

6.4.1.5 Sub Camps

Apart from Camp 5 at Melinau Gorge, the park also maintains three other camps for visitors going to other parts of the Park. These are the Paku (Camp 1), Kapur (Camp 3) and Lumut (Camp 4). No new facilities will be built but the existing facilities shall be improved.

6.4.2 PARK INTERPRETATION

Interpretation seeks to achieve three objectives (Sharpe 1976):

To assist the visitor in developing a keener awareness, appreciation, and understanding of the area he or she is visiting. Interpretation should help to make the visit a rich and enjoyable experience.

To achieve its management goals of:
Interpretation can encourage thoughtful use of recreation resource on the part of the visitor, helping reinforce the idea that parks are special places requiring special behaviour.

Interpretation can be used to minimise human impact on the resource by guiding people away from fragile or overused areas into areas that can withstand heavier use.

To promote public understanding of an agency and its programmes. Every agency has a message to convey. Well-done interpretation favourably promotes the image of the agency which supplies it. If it is overdone, the message is labelled propoganda, rather than interpretation or public information.

6.4.2.1 Policy on Interpretation is as follows:

1) A basic purpose of park interpretation is to enable the public to use, understand and appreciate National Parks, and the natural history and to gain support for conservation.

2) Qualified personnel and interpretive services must be provided.

3) Interpretation centres, where desirable, should be provided and administered by National Park Authority.

6.4.2.2 Interpretation programmes currently in place are:

1) Brochures. The brochure introduces visitors to the park, its important resources, types and locations of activities, point of interest and various activities.

Self-guiding leaflets on plants and animals. Self-guiding leaflets on items of interest eg. bird watching, common plants, animals in the park need to be prepared. With the park guide's help, visitors would be able to appreciate this more.

2) Visitor centre. This is an important tool to get information to visitors. Officers should be stationed there and answer visitors´ questions.

The park is organizing public relations and communication training courses for its staff with the intention of increasing personal contact with visitors. Visitors would thus be able to have greater access to more information. The park also intends to have more public relations with locals to promote understanding and cooperation. The Forest Department Environmental Education Unit intends to have a follow up of its education programme conducted in 1990.

3) Audio-visual programmes

The park has an audio-visual room at the interpretation centre. The room has a video, television and can house about 50 people comfortably. General videos on the park and caving are available for screening to the visitors upon request.

Once the staff have been trained in public relations and communications the park will have nightly interpretive talks. This will include question and answer sessions.

4) Interpretive structures

Signs are placed at entrances to caves and on junctions to trails.

More interpretive signs on the use of specific plants will be placed along the trails. Plants names alone are insufficient as it is known that visitors will enjoy their stay if more interpretive work is done.

6.5 **WILDLIFE MANAGEMENT**

6.5.1. INTRODUCTION

The single most important step needed to conserve the Park's wildlife is thorough protection of all habitats inside the boundaries (forests, mountains and caves), and control of land use outside the boundaries (Sections XX and XX). Even with such protection, additional measures are needed to ensure that the animals and plants are not exterminated by over-exploitation or bad management. This section outlines the management steps which should be taken to ensure full survival of the Park's wildlife.

6.5.2 HUNTING PRESSURE

The question of illegal hunting (ie. poaching) is dealt with in section 6.3. The present section is concerned with hunting by those people with gazetted privileges to hunt inside the Park for meat for their own consumption (Section 4.1.1).

Incidental observations imply that hunting is unsustainably high, and that certain species have declined in numbers (e.g., Andersôn *et al.*, 1982; M. Meredith, pers. comm.). In this case, Park management should take all possible action to reduce hunting pressure.

6.5.2.1 Hunting by local people

A study will be conducted to investigate:
- how many people are hunting, and who they are;
- their dependence on the meat, and possible alternative sources of protein;
- what they are hunting;
- the impact of hunting on wildlife populations, and its sustainability.

The results will be used to determine the action to be taken:
- whether there should be a total ban on hunting of certain species;
- whether closed seasons are needed for hunting certain species;
- possible zoning of hunting within the Park;
- alternative sources of protein to reduce dependence on wild meat;
- conservation education programmes to allow implementation of the regulations;
- measures needed to enforce the regulations.

6.5.2.2 Provision of wild meat for visitors

It is legal for visitors to be offered wild meat for sale or for consumption provided it has been hunted outside the Park and it is not from a protected or totally protected species. However, the following points suggest that it is undesirable and should be discouraged:

(1) if the meat has been hunted inside the Park and then sold, it is illegal;

(2) it is impossible to determine where the meat has been hunted: this provides a legal loophole for anyone hunting meat for commercial purposes inside the Park;

(3) it presents visitors with the wrong image of conservation in Sarawak. All efforts should be made to teach visitors the meaning of conservation and appreciation of wildlife, and giving them wild meat undermines that message;

(4) it is impossible to convince local people of the need to control hunting if they see the authorities condoning it, companies profiting by it, and "their" meat being eaten by outsiders;

(5) it is an additional drain on wildlife populations. The Park is undoubtedly acts as a reservoir of wild meat for surrounding, more disturbed areas. Hunting by local people for their own needs is almost certainly already unsustainable in the peripheral areas, and additional hunting would aggravate this. Wild meat is not essential for visitor survival, so should not be sold.

NPWO will take steps to discourage the consumption of wild meat by visitors; specifically -

- sale and consumption of wild meat will be banned on Park premises;
- posters will be displayed at the visitor centre to draw visitors attention to the problem;
- tour operators will be invited to sign an undertaking not to serve wild meat and the names of those who do so will be displayed at the Park;
- those responsible for VIP visits will be informed of the Department's position on this, and the embarassment which could arise if wild meat is served to the VIP.

6.5.2.3 Other wildlife products

Wildlife products from protected and totally protected species such as bear claws, clouded leopard teeth, gibbon skulls and hornbill ivory are sometimes offered to tourists on the way in and out of Mulu (e.g., in Marudi; at Kuala Baram; on express boats). Moreover, private tourist guides sometimes wear wildlife products (e.g., bear claws). A major effort is needed by all wildlife rangers and Police to prevent this because:

(1) it is illegal;

(2) it is potentially a major drain on wildlife populations of northern Sarawak (inside and outside the Park), and will increase as the tourist trade increases;

(3) it presents people with the wrong image of how Sarawak regards conservation, and of the willingness of the authorities to

protect its wildlife.

Preventive measures are:

- education of wildlife rangers and Police about what animals are protected and totally protected, and how to recognise them and their products;
- widespread publicity material about protected and totally protected species, and penalties for infringing the law. This should be provided by tour companies, at the entrance to the Park, and in all hostels, lodges and hotels around the Park;
- frequent patrols by wildlife rangers and Police to potential points of sale;
- confiscation of all illegal wildlife products;
- prosecution of traders under the Wild Life Protection Ordinance 1990;
- confiscation of wildlife products from tour guides and tourists, and prosecution of serious and repeated offenders.

6.5.3 CONTROL OF FISHING

The Park is extremely important in conserving rare fish species. It is also a vital reservoir of fish for consumption by local people all along the Baram and Tutoh rivers (Section 4.1.1). Although the main rivers which form the Park boundaries are outside the Park, NPWO should discourage fishing by visitors.

It is illegal for any outsiders to fish inside the Park. No exceptions should be made under any circumstances, including visits by VIPs. This is because:
(1) it is illegal;
(2) it presents visitors with the wrong image of the Park and conservation. Such visits should be used to emphasise the value and meaning of conservation. Conservation of endangered fish and of fish stocks is part of this message, and allowing them to infringe regulations and fish inside the Park undermines that message;
(3) it sends the wrong image to local and foreign visitors if Park authorities condone illegal fishing.

Preventive measures are:
- Regular patrol by Park Rangers to areas prone to illegal fishing.
- Offenders will be prosecuted.

6.5.4 CONTROL OF PLANT COLLECTION

Many of the plant species in the Park are extremely rare, both within the Park, and worldwide (Section 3.3). These include the pitcher plants and many of the orchid species (Section XX; Kiew, 1991). Many of these are disappearing from the main tourist venues, presumably a result of illegal collection by visitors. All efforts must be made to control this.

The importance of plant protection, and the relevant regulations and penalties will be stressed during training for Park Guides;

Park Guides will brief their party of visitors on the importance of plant protection before they enter the Park;

All plant material collected by visitors will be immediately confiscated;

Major and repeated offenders will be prosecuted.

A study will be made on the extent of the problem and additional ways to control it.

6.5.5 CONSERVATION OF BATS

All efforts are needed to protect Mulu's bats because:
- the bat colonies are important on a world scale;
- they are one of the main tourist attractions in the Park;
- bats are essential pollinators and seed dispersers for many rain forest trees (Sunquist, 1992), including commercial species such as durians, bananas, jackfruit and petai. Mulu's bats fly to forests many tens of kilometers away and, without them, many of the trees in those forests will be unable to produce fruits and to reproduce. Without them, many domestic fruit crops are threatened, as is the survival of many species of rain forest tree in the Park and surrounding areas. In Selangor, for example, bats that roost in Batu Caves support a durian industry worth thousands of ringgit, and also maintain the trees of mangrove forests up to 50 km away (Lee, 1980).

Park Guides will ensure that disturbance inside roosting caves is minimised (Section XX);

Visitors will not be permitted to enter caves or cave passages where disturbance to bats is unavoidable (eg. Bat Cave, near the north entrance to Deer Cave);

Disturbance around cave entrances will be minimised. In particular, there will be no further clearance of forest in front of Deer Cave for any purpose whatsoever.

The Department will inform all those operating flights into the area (MAS, TUDM, etc) of the dangers of aircraft flying into groups of bats and urge them to avoid times when bats are emerging from or returning to the caves.

6.6 RESEARCH PROJECTS

From 1977 to 1979, a series of research projects was conducted in the Park, and these formed the basis of the initial management plan (Anderson *et al.*, 1982). Since then, several caving expeditions have greatly extended knowledge of the Park's caves (Eavis, 1985; Meredith *et al.*, 1992), but few other studies have been conducted. In the meantime, there have been very major changes around the Park (Section 6.4). Thus, for long term management of the Park, considerable further research is necessary to ensure that use of the Park is sustainable, and that the flora, fauna and environment of the Park are fully conserved.

To generate interest in the Park and its conservation, a wide range of research projects on its geology, ecology and wildlife should be encouraged. If somebody has enthusiasm, ability and funding for a project, it should be allowed as much as possible; all such projects offer training for staff, and provide data of potential use to Park managers.

Conservation priorities of particular importance to management inevitably shift according to changing pressures on the Park. The management plan written in 1982 did not even remotely envisage the development patterns, land use and tourism of 1992. The following list of research priorities is not to be seen as the only projects worth doing, therefore, and priorities will inevitably change. It is a list of projects for which researchers should actively be sought and encouraged now, and whose results are urgently needed to ensure sound management of the Park in future.

6.6.1 Studies in the forests

1. Monitoring populations of large mammal and birds. No surveys of the birds have been conducted since 1978 (Wells *et al.*, undated). and no surveys of the number of large mammals in the Park have ever been conducted. For management, it is essential to know which areas are most important for wildlife (critical habitats, breeding sites, and the reaction of different species to recent pressure on the Park). Monitoring population levels is essential to ensure that they are not declining as a result of increased pressure on the Park. Being at the top of the food chain, and critical for pollination, dispersal and maintaining the health of a forest, large mammals and birds are vital indicators of the health of a forest. Thus, monitoring their numbers shows how healthy the Park is, and if any management measures are needed. The main questions to be addressed are:
   - .The habitat requirements of different species of large mammals and birds, including which habitats are most important, and population densities;
   - .if the populations are increasing, stable or decreasing, and the likely causes of changes.

2. A study of the sustainability of hunting inside the Park by

local people. Local people have privileges to hunt within the Park. In other parts of Sarawak, hunting of certain species by indigenous people is not sustainable, even if it is only for their own subsistence (Bennett, 1992). If animals are hunted too heavily, this will result it: (1) extinction of certain species inside the Park; (2) loss of a potential meat supply for rural people who depend on it; (3) threat to the balance of the forest, which is at least partly maintained by the larger animals. The main questions to be addressed are:

- .if hunting by local people inside the Park is sustainable for all of the animals hunted;
- .if not, what measures are necessary to control hunting. Possible options are controls on which species are hunted, which areas are used for hunting, bag limits, closed seasons;
- .what are alternative and economic sources of protein for local people to reduce their dependence on wild meat.

3. A study of the effects of tourism on populations of wildlife inside the Park. Some species are more vulnerable to disturbance than others. Studies of disappearance of animals from frequented tourist spots and Park boundaries is essential in planning future visitor facilities to minimize the impacts on wildlife.

4. Studies on the ecological requirements of rare and endemic species. In particular, details are needed of where animals occur, where they feed and breed. This is especially needed for larger, more mobile animals encountered in a variety of habitats, but possibly dependent on one or two specific areas for survival.

5. A study of bats and swiftlets. This is to assess their habitat needs inside and outside the Park, and is vital to ensure that developments in the Park do not jeopardise the bats and swiftlets.

6. A study on use of non-timber forest products by Penan and other local people. The Penan are being strongly encouraged to make and sell handicrafts to tourists. Many of these are made from rattan which is taken from the Park. It is illegal for them to collect produce from the Park for sale, and also is a major drain on the rattans of the Park. The effects of their collection, economic dependence on it, alternative sources of supply and alternative sources of income should be studied.

Other, shorter research projects in the forests of relevance to management are (after Meredith, undated):

1. A study of the life cycles of invertebrates, with details of food plants or prey species. Many larval forms cannot be definitely related to adult forms, making management of endangered species impossible. Development of expertise in rearing animals in the laboratory would answer such questions.

2. A study of invertebrate populations in the canopy, including communities centred on epiphytes. There have been studies on the faunal diversity at ground level, but little is known about life in the canopy.

3. An ethnobotanical study of local people, including their use of plants as medicines. This could result on a specialised nature trail, of value for research and education.

4. A study of the structure of termite and ant communities and commensals. These are critical components of a forest, so studying their ecology, habitat needs and responses to disturbance are critical in maintaining the health of the forest.

5. A survey of fungi and lichens. Indications of the distribution of highly localised endemic species could affect sitings of trails, huts etc.

6. A study of tree falls and regeneration in different forest types. Development of a system of recording tree falls, together with routine work in new gaps, will provide invaluable data on forest regeneration, of relevance throughout Sarawak.

7. Making recordings of bird calls and other forest sounds. This would be highly useful in carrying out wildlife surveys since many animals are more easily heard than seen. It would also be extremely useful for tour guides in Park interpretation, to make the Park even more interesting for all visitors.

8. A study of the composition of "bird waves" and mixed feeding flocks of birds. This would be primarily of educational value as an example of resource partitioning and feeding strategies.

9. A survey and study of otters in the Park. Otters are delightful animals to watch, but are easily disturbed where rivers are used for transport. The study would aim to investigate the possibility of tourist viewing, and also the conservation needs of the animals.

10. A survey of suitable sites for hides to observe birds and mammals, relevant to planning of tourist facilities.

11. A study of the use of cave entrances by animals. This is essential when planning visitor use of caves, especially since entrances are often used for picnicking and sleeping.

12. A study of pesticide residues in Mulu bats and birds, with special attention to those which feed outside the Park. This would be used as a baseline study to evaluate future trends.

13. A study of the presence and origins of migratory birds. Recording arrivals and departures, and ringing the birds, will provide data for future management all along their migration route, inside and outside Sarawak.

14. A study of endemic orchids and, if properly planned, establishment of an orchid garden near to the Park headquarters (similar to the one in Kinabalu Park). This would be a visitor attraction, and also a resource for research and education. Before

starting, a full study is needed to ensure that collection for a garden does not have any impact on wild populations of the plants.

15. A study of parasitic and saprophytic plants. A survey of the plants, and identifying hosts and substrates, is necessary for management since plants which are highly specialised in this way could be endangered.

16. A study of the ecology of pitcher plants. Aspects of interest include the relative importance of the pitcher for food and water supply for other species; living communities inside the pitcher. The information is important for education and interpretation, to discourage disturbance of pitchers by visitors.

17. A medical study of potential human pathogens (e.g., leptospira, histoplasmosis, malaria) and their vectors. This is important in understanding disease prevention amongst visitors, staff and local people.

18. A study of the pests and diseases of wild fruit trees. The forest is often viewed as a "gene bank" of use in breeding disease-resistent domestic species. Some knowledge of diseases occurring in the forest is a key factor in this.

19. A study of the distribution patterns of figs and lowering sequences. Figs are critical in the ecology of a rain forest. They are the major source of food for many large animals (e.g., gibbons, macaques, hornbills, barbets, bulbuls, pigeons), which, in turn, are vital in pollinating and dispersing the fruits of other species. Survival of fig species depends on fig wasps, particularly the ability of the wasps to leave on fig tree and find another in flower. An estimate of the numbers and distribution patterns of fig trees is necessary to ensure against accidental extinction of a species in Mulu, and the wave of ecological disturbance throughout the community which this might precipitate.

6.6.2 Studies in the caves

1. A faunal survey of the caves. This is especially important to identify those species which are restricted to one or a few caves, and must be taken into account in plans to for visitor use of caves.

2. A study of the nutrient content and micro-fauna of percolation water. Some cave dwellers probably depend on food originating in overlying soils and brought in by water penetrating tiny cracks. Part of this would be a study of "phreatobites", since information on this will guide decisions on management of the limestone surface.

3. A study of bacteria and fungi in the dark zone, including fungal or lichen colonies (as in Mayday Cave). These might play a key role in the food chain, yet are susceptible to any cave

development which causes changes in air currents and humidity.

4. Establishment of permanently marked study sites in caves. Correlation of faunal distribution with sediment analysis, weather recordings, changes in visitor use etc. can only be conducted when data are always collected from the same site.

5. A study of growth rates of stalactites and stalagmites. This is needed for interpretation and education, especially to persuade visitors not to destroy formations.

6. A study of entrance flora and photokarst. Photokarst is well developed only in large tropical caves. A better understanding of the phenomenon is essential if the impact of development plans is to be assessed.

7. A biological study on the Superficial Underground Compartment (SUC), i.e., the open spaces in soils and gravels. Many species which are rare in caves might be abundant in the SUC. This needs to be investigated in order to assess the priority and ways to protect cave species.

8. Exploratory surveys to discover new caves. Of special interest are possible new "wild" caves near Lubang Nasip Bagus, and a potential new show cave near Batu Rikan or Melinau Gorge. These are additional visitor attractions, as well as being important sites for interpretation and education.

9. Exploratory surveys to extend existing caves, e.g., increasing the known length of Clearwater Cave and linking caves in G. Benerat. This helps to maintain Mulu's reputation for large caves, which is important in persuading people of the need to protect the area.

6.6.3 Research Priorities

6.6.3.1 Faunal Survey

(i) Monitoring and inventorying species of mammals and birds and determine the pop. densities
(ii) To study the habitat requirements of different species of large mammals and birds and to identify which habitats are most important
(iii) Study on cave fauna and inventory.

6.6.3.2 Bats and Swiftlets Conservation & Ecology

This involves the study of the pop. dynamics, foraging behaviour and habitat requirement inside and outside the Park. This is vital to ensure that developments in and around the Park do not jeopardise the bats and swiftlets.

6.6.3.3 Study on hunting by the previleged local people in the Park

This is to determine the sustainability of hunting in the Park and come up with controlling measures and options.

6.6.3.4 Study on the utilisation of non-timber jungle produce by the Penans and other local people

This study will determine the requirement for certain produce used and the qualities, and the sustainability. Alternative sources of supply and alternative sources of income will also be studied.

6.6.3.5 Study on the effects of tourism on Mulu N.P.

This study will look into the impacts on wildlife population, habitats and on the general environment.

6.7 IMPLEMENTATION AND MONITORING

It is now generally recognised that arrangements for monitoring implementation of plans are vital. In the light of this some kind of formal review procedure does need to be set up. Monitoring provides a feed back that will enable prescriptions to be revised periodically.

The Forest Department's Park committee will meet at least twice a year, preferably at G. Mulu N.P. to discuss the matter. Any problems arising would be dealt with and prescriptions would be amended if it is necessary to do so.

6.8 MANAGEMENT SCHEDULE

Management Programs	1993	1994	1995
A. Community Development			
1. Public Education & Extension service	x	x	x
2. Other Community Work	x	x	x
B. Park Administration			
1. Staffing			
i) Park HQ Personnel	x	x	x
ii) Mentawai Ranger Post Personnel	x	x	x
2. Training			
i) Conservation & Management Courses	x	x	x
ii) Inhouse training	x	x	x
3. Equipment and Machinery			
i) Increase in HQ equipment and machinery	x	x	x
ii) Increase in Ranger Post equipment	x	x	x
iii) Water treatment	x	x	x
C. Law Enforcement			
1. Control of Entry			
i) Visitor monitoring programme	x	x	x
ii) Introducing and monitering of Professional permit	x	x	x
iii) Issuing of privilege permit & monitering	x	x	x

Management Programs	1993	1994	1995
2. Boundary Patrol			
i) Aerial survey and patrol	x	x	x
ii) Ground survey and patrol	x	x	x
3. Boundary Marking & Maintenance			
i) Cleaning of cut line A & F	x	x	x
ii) Marking of boundaries following navigable rivers (B, C & F)	x	x	x
4. Extension of National Park	x	x	x
D. **Visitor Use**			
i) Maintenance of existing trail	x	x	x
ii) Development of new trails	x	x	x
iii) Maintenance of sub-camp	x	x	x
iv) Construction of new sub-camp (Camp 3)	x		
v) Construction of a Hostel for Melinau Camp	x		
vi) Improvement of Interpretation Centre and Audio-Visual Facilities	x	x	x
*vii) Installation of refuse Disposal System	x		
viii) Improvement of visitor area at Deer Cave	x	x	
ix) Maintenance of walkway both outside and inside caves	x	x	x
x) Maintenance of waterway	x		
xi) Improvement of cave lighting	x		
xii) Maintenance of cave lighting	x	x	x
xiii) Construction of a suspension bridge at Melinau Camp	x		
xiv) Improvement of visitor facilities at Mentawai Ranger Post	x	x	x
xv) Improvement of Park HQ facilities	x	x	x
*xvi) Rubbish disposal	x	x	x
E. **Park Interpretation**			
i) Prepare/Reprint brochures	x	x	x
ii) Organise public relation programme with visitors and local communities	x	x	x
iii) Special education programmes	x	x	x

CHAPTER 7 BUDGET (1993 - 1995)

	Items	Estimated Budget ('000)		
7.1	**Recurrent Fund (Head S.35 Perhutanan)**	**1993**	**1994**	**1995**
7.1.1	<u>Management of Boundaries (137.2 km @ 1.00 per meter):</u>	138	138	138
7.1.2	<u>Maintenance of Path, Bridges, Trails, Jetties & Plankwalks:</u>	125	135	135
	a) Plankwalk from Park HQ to Deer Cave - 3 km			
	b) Plankwalk/Footpath/Deer & Lang Caves - 1.5 km			
	c) Wind Cave Plankwalk - 45 km			
	d) Clearwater Plankwalk - 55 km			
	e) Summit Trail - 24 km			
	f) K. Berrar-Melinau Gorge Trail - 5 km			
	g) K. Terikan-Melinau Gorge Trail - 12 km			
	h) Bridges - 15 nos			
	i) Jetty - 4 nos			
	j) Melinau Gorge-Pinnacle Trail - 3 km			
	k) HQ-P. Bangan-B. Bungen-HQ Trail - 6 km			
	l) HQ-Clearwater Cave Trail - 3.5 km			
7.1.3	<u>Maintenance of Buildings</u>	95	50	50
	a) 1 VIP Resthouse & Annexe			
	b) 4 nos. 6-Door Barrack			
	c) 5 nos. class 4 Quarters			
	d) 2 nos. Office Interpretation Centre			
	e) 1 nos. Store Building			
	f) 1 nos. Bat Observatory			
	g) 1 nos. 4-Door Barrack			
	h) 4 nos. Hostels			
	i) 6 nos. Chalets			
	j) Generator House cum Store at Deer Cave			
	k) Generator House cum Store at Clearwater Cave			
	l) Mountain Huts (Camp 1 & 4)			

	Items	Estimated Budget ('000)		
		1993	**1994**	**1995**
7.1.4	<u>Casual Labour:</u> a) 3 Amahs b) 2 Plant Attendants c) 4 Boathands d) 2 Gardeners e) 2 Carpenters f) 7 Labourers g) 15 Park Guides	135	150	150
7.1.5	<u>Furnishing of Resthouse & Hostels:</u> a) 1 no. VIP Resthouse - 3 rooms x 2 beds + 8 rooms x 6 beds = 54 beds b) 1 no. Resthouse Annexe - 1 room x 3 beds + 1 room x 30 beds = 33 beds c) 6 nos. Chalets - 12 rooms x 2 beds = 24 beds d) 2 nos. Hostels - 8 rooms x 4 beds = 32 beds e) 1 no. Canteen - 1 room x 2 beds = 2 beds f) 1 no. Hostel at Mentawai - 4 rooms x 10 beds = 40 beds g) 1 no. Hostel at Melinau Gorge - 6 rooms x 10 beds = 60 beds	30	50	50
7.1.6	<u>Fuel & Maintenance Of Plants:</u> (Generator Sets, Chainsaws, Bush Cutters, Water Pumps, Outboard Engines & Lawn Mowers)	250	250	250
7.1.7	<u>Publicity:</u> a) Conservation Education Programme b) Store & Equipment c) Cooking Utensils d) Printing & Stationeries	10	10	10
7.1.8	<u>Store & Equipment:</u> a) Outboard Engines (including parts) b) Cave Equipment c) Building Equipment & Hardware	20	20	20

Items		Estimated Budget ('000)		
		1993	**1994**	**1995**
7.1.9	Office Expenses (miscellaneous):	5	5	5
7.1.10	Personal Emoluments (Permanent Establishment):			
	a) 1 Scale A Officer-In-Charge	18	20	22
	b) 3 Forest Guards (D10)	25	28	30
	c) 2 Permanent Labourers (D11)	15	17	19
7.1.11	Transport & Travelling:	125	125	125
	a) 1 Scale A Officer			
	b) 5 Scale D Officers			
	c) 25 Casual Labourers			
	SUB-TOTAL (RECURRENT):	991	998	1,004

7.2 **Development Fund** (See Notes)

Notes:

1. * Funds from Federal Ministry of Culture, Arts, & Tourism.

2. ** Funds direct from State Ministry of Environment & Tourism.

3. The rest to come from National Parks & Wildlife Branch's Development Fund Allocation (Head 86/01).

Items		Estimated Budget ('000) 1993	1994	1995
7.2.1	Mentawai Ranger Station:			
	a) 1 x 4 Door Barrack		200	
	b) 1 no. Administrative Block	265		
	c) 1 no. Hostel		355	
	d) 2 nos. Staff Quarters			220
	e) Plankwalk & Shelters			105
	f) Pontoon Jetty	70		
	g) 1 Incinerator	20		
	h) Utilities (Electricity & Water Supply)	200	120	120
	i) Furniture	50	50	50
	j) Site Preparation Works & Preliminaries	40	40	40
	k) Consultancy Fees	67	67	67
7.2.2	Park Headquarters (Sg. Melinau):			
	a) Path & Compound Lighting	150	146	
	b) 2 nos. Chalets *	550		
	c) Water Treatment Plant	20		200
	d) 2 x 6 Door Staff Barrack **	200	200	
	e) Retaining Wall **	150		
	f) Public Toilet *	74		
	g) Multi Purpose Hall			200
	h) Footpath/Plankwalk To Staff Housing Area **	150		
	i) Plankwalk/Trail to Clearwater Cave *	610		
	j) Shelters, Benches & Toilets along Nature Trail (HQ - P.Bangan - B.Bungan - HQ)		50	100
	k) Shelters along Deer Cave Plankwalk			50
	l) 1 Incinerator	20		
7.2.3	Melinau Gorge (Camp 5):			
	a) 1 no. Hostel/Transit Camp *		220	
	b) Suspension Bridge *		200	
	c) Renovation to Existing Hostel			50
	d) 1 Incinerator		20	
7.2.4	Show Caves:			
	a) Public Toilet, Picnic Facilities & Mini-Dam at Deer/Lang Cave Entrance	75	100	100

Items	Estimated Budget ('000)		
	1993	**1994**	**1995**
b) 2 nos. 30 kw Generators at Deer, Lang, Wind & Clearwater Caves c/w re-wiring (Total: 6 nos. Generators) **	350		
c) Bridge at Clearwater **	50		

7.2.5 Sub-Camps:

a) Improvements to Mountain Huts at Camp 1 (Paku), Camp 3 (Kapur) & Camp 4 (Lumut)		150	
SUB-TOTAL (DEVELOPMENT):	3,551	1,528	1,252
GRAND-TOTAL: (RECURRENT & DEVELOPMENT):	4,542	2,526	2,256

7.3 Research Fund

Notes:
1. * Fund from Federal Wildlife Conservation project.
2. ** Fund from State Wildlife Management.
3. *** Fund from Development Fund allocation (Head 86/01).

Items	Estimated Budget ('000)		
	1993	**1994**	**1995**
a) Faunal Survey (General) *	20	20	-
b) Bat Conservation & Ecology *	15	10	-
c) Study on the hunting pattern of the Penans and its implication of the Mulu N.P.**	-	20	-
d) Study on the utilisation of jungle produce by inhabitants around Mulu N.P. ***	-	-	30

Items	Estimated Budget ('000)		
	1993	**1994**	**1995**
e) Study on the effects of tourism in Mulu N.P. ***	-	-	30

7.4 **SUMMARY**

A) Total of Recurrent Expenditure (1993-1995) : 2,993,000

B) Total of Development Expenditure (1993-1995): 6,331,000

C) Total of Research Expenditure (1993-1995) : 145,000

D) Grand Total (A+B+C) : 9,469,000

The Gunung Mulu National Park Proclamation

SARAWAK GOVERNMENT GAZETTE

2359 [3rd October, 1974

No. 2852

THE NATIONAL PARKS ORDINANCE

THE GUNONG MULU NATIONAL PARK PROCLAMATION

(Made under section 7(2))

1. This Proclamation may be cited as the Gunong Mulu National Park Proclamation, 1974.

2. The land described in the Schedule shall with effect from 1st August, 1974 be constituted a National Park, to be known as the Gunong Mulu National Park.

3. The privileges conceded within the National Park shall, subject to the provision of section 14 of the National Parks Ordinance, be as follows:

(*a*) The inhabitants of the following longhouses under the jurisdiction of Penghulu Baya Malang:

Kuala Tutoh (Long Kiput)

Batu Belah

Long Panai

Long Terawan

Long Melinau

Sungei Iman

Sungei Abang

Sungei Ubong

Sungei Tapin

shall have the privilege of hunting pig (*Sus* spp.) and deer (*Tragulus* spp., *Muntiacus* spp. and *Cervus* spp.) within the drainages of the Sungei Melinau Paku, Sungei Lansat, Sungei Tapin and other small rivers draining into the Sungei Tutoh between Long Tapin and Long Melinau.

(*b*) The inhabitants of the longhouses mentioned in paragraph (*c*) above shall have the privilege of taking fish from the Sungei Melinau Paku, Sungei Lansat, Sungei Tapin and other small rivers draining into the Sungei Tutoh between Long Tapin and Long Melinau and all tributaries of these rivers.

(*c*) The inhabitants of the longhouses mentioned in paragraph (*a*) above shall have the privilege of collecting from the areas mentioned in paragraph (*a*) the following forest produce:

(i) damar,

(ii) rotan,

(iii) getah, including jelutong, getah rian, and malau,

(iv) pandan leaves, and leaves of other plants, for basket making and weaving,

(v) edible plants or parts thereof, including fruits, leaves, roots.

(*d*) Nomadic Punans living within the Park, shall have the privileges mentioned in paragraphs (*a*) to (*c*) above but such privileges shall cover the

APPENDIX 2. SCIENTIFIC NAMES OF ANIMALS MENTIONED IN THE TEXT.

Names of animals are drawn from the following texts: Mammals: Payne *et al.*, 1985; birds: *Smythies*, 1982.

English name	Scientific name
MAMMALS	
Barking deer	*Muntiacus sp.*
Bearded pig	*Sus barbatus*
Binturong	*Arctitis binturong*
Black flying squirrel	*Aeromys tephromelas*
Bornean gibbon	*Hylobates muelleri*
Bornean mountain ground squirrel	*Dremomys everetti*
Clouded leopard	*Neofelis nebulosa*
Colugo or flying lemur	*Cynocephalus variegatus*
Common palm civet	*Paradoxurus hermaphroditus*
Grey fruit bat	*Aethalops alecto*
Horse-tailed squirrel	*Sundasciurus hippurus*
Hose's langur	*Presbytis hosei*
Jentink's squirrel	*Sundasciurus jentinki*
Kinabalu squirrel	*Callosciurus baluensis*
Lesser tailless roundleaf bat	*Coelops robinsoni*
Long-tailed macaque	*Macaca fascicularis*
Long-tailed porcupine	*Trichys fasciculata*
Malay civet	*Viverra tangalunga*
Maroon or red langur	*Presbytis rubicunda*
Mongoose	*Herpestes sp.*
Moonrat	*Echinosorex gymnurus*
Mountain treeshrew	*Tupaia montana*
Mouse deer	*Tragulus sp.*
Orange tube-nosed bat	*Murina cyclotis*
Orang-utan	*Pongo pygmaeus*
Painted treeshrew	*Tupaia picta*
Pig-tailed macaque	*Macaca nemestrina*
Plain pygmy squirrel	*Exilisciurus exilis*
Plantain squirrel	*Callosciurus notatus*
Prevost's squirrel	*Callosciurus prevostii*
Sambar or rusa deer	*Cervus unicolor*
Silvered langur	*Presbytis cristata*
Slow loris	*Nycticebus coucang*
Small-toothed palm civet	*Arctogalidia trivirgata*
Smooth-tailed treeshrew	*Dendrogale melanura*
Sun bear	*Helarctos malayanus*
Three-striped ground squirrel	*Lariscus insignis*
Tufted ground squirrel	*Rheithrosciurus macrotis*
Western tarsier	*Tarsius bancanus*
Whitehead's pygmy squirrel	*Exilisciurus whiteheadi*
Wrinkle-lipped bat	*Tadarida plicata*
Yellow-throated marten	*Martes flavigula*

BIRDS

Ashy bulbul	*Hypsipetes flavula*
Bamboo munia	*Erythrura hyperythra*
Banded kingfisher	*Lacedo pulchella*
Bat hawk	*Machaeramphus alcinus*
Black-and-red broadbill	*Cymbirhynchus macrorhynchus*
Black-and-white bulbul	*Pycnonotus niewenhuisi*
Black-capped kingfisher	*Halcyon pileata*
Black wood partridge	*Melanoperdix nigra*
Blue-eared kingfisher	*Alcedo meninting*
Brown-rumped (edible-nest) swiftlet	*Collocalia vestita*
Bulwer´s pheasant	*Lophura bulweri*
Chestnut-collared kingfisher	*Halcyon concreta*
Common sandpiper	*Actitis hypoleucos*
Crested fireback	*Lophura ignita*
Crested wood partridge	*Rollulus rouloul*
Crestless fireback	*Lophura erthrophthalma*
Great argus pheasant	*Argusianus argus*
Ground-cuckoo	*Carpococcyx radiceus*
Helmeted hornbill	*Rhinoplax vigil*
Kinabalu serpent-eagle	*Spilornis kinabaluensis*
Little green heron	*Butorides striatus*
Ochraceous bulbul	*Criniger ochraceus*
Oriental darter	*Anhinga melanogaster*
Pale-faced bulbul	*Pycnonotus flavescens*
Peregrine falcon	*Falco peregrinus*
Red-breasted partridge	*Arborophila hyperythra*
Rhinoceros hornbill	*Buceros rhinoceros*
Rufous-backed kingfisher	*Ceyx rufidorsus*
Stork-billed kingfisher	*Pelargopsis capensis*
Storm´s stork	*Ciconia stormi*
Tiger bittern	*Gorsachius melanolophus*
Whitehead´s trogon	*Harpactes whiteheadi*
Wreathed hornbill	*Rhyticeros undulatus*

REPTILES AND AMPHIBIANS

Banded coral snake	*Maticora intestinalis*
Bronze-back	*Ahaetulla prasimus*
Cave racer	*Elaphe taeniura*
Keel-bellied whip snake	*Dryophiops rubescens*
Red-headed krait	*Bugarus flaviceps*
Reticulated python	*Python reticulatus*
Wallace´s flying frog	*Rhacophorus nigropalmatus*

INVERTEBRATES

Eyeless crab	*Cerberusa caeca*
Cave cockroach	*Trogloblattella chapmani*

small for many large animals. Adding the whole upper Medalam would significantly increase the chances of survival of some species.

iv) Enforcement of Park regulations in the Medalam area will be greatly simplified it both banks of the river are subject to the same Ordinance.

v) There will be increasing demand for recreational and educational facilities totally within the Park but easily reached; sites along the Medalam river will be suitable provided both banks are in the Park.

vi) Long-term research into the effects of logging and the natural regeneration of logged forest of various types would be possible if further disturbance is prevented.

vii) The Department could gain experience of the management of hunting in logged-over forest to maximise yields; this could be applied elsewhere in Sarawak.

1.5 Privileges

When notice of intent to create Mulu was given in 1964, Pengarah Ngang and Penghulu Gawan objected that the boundary came too close to longhouse. This objection was withdrawn when it was explained that only the true left bank of the Medalam was in the proposed park "and that there was no objection to Ibans taking timber and forest produce for their own purposes from the drainages of the Assam and Budu rivers" (CF.907/G. Mulu/1-61 dated 4.3.66).

The same report notes that Iban hunters under Pengarah Ngang and Penghulu Gawan visited the Mentawai and should be allowed privileges there. However, the final proclamation accords hunting and gathering privileges in the Mentawai catchment to the Murut people under Penghulu Madang, not to the Iban!

In view of the above, considerable opposition to the proposal can be expected from the local Ibans.

The report states that the Iban considered Ulu Terikan and the true left bank of the Medalam to be Penan territory, implying that the Iban hunted on the true right bank.

We must ensure that the Iban people in the two nearest longhouses are accorded privileges along the true right bank of the Sungai Medalam as far as the Medalam Gorge. Proper management of the area should provide considerable wild-meat on a sustainable basis.

The question of fishing privileges should be dealt with after discussion of the resources available with the Agriculture Department specialists.

2 UBUNG

2.1 Boundaries

The eastern half of the catchment of the Sungai Ubung, so that the whole catchment is inside the Park; approximately 40,000 acres.

2.2 Reasons for exclusion from present Park

The present boundaries are as suggested by the original report (CF.907/G. Mulu/1-1a undated); no reasons were given for the choice of features used.

2.3 Description

The proposed extension contains mixed dipterocarp forest on the lower slopes with montane forest at higher altitudes on Gunung Mulu.

The forest is currently being logged, but this will have little effect on the montane forest.

This is one area which is still used by groups of nomadic Penan.

2.4 Justification for the extension

i) Enforcement of Park regulations in the Ubung catchment is extremely difficult. If improved access along logging roads leads to the establishment of farms along the left bank, regulation of hunting, etc within the Park will be virtually impossible. The water-shed between the Ubung and the Magoh would be a more realistic boundary.

ii) When a major highway connects Long Seridan with Long Lama and Miri, there will be a demand for visitor facilities at Long Ubung; this can be better provided if the larger area is within the Park.

iii) Long-term research into the effects of logging and the natural regeneration of logged forest would be possible if further disturbance is prevented.

iv) The regenerated forest would take hunting pressure off the Park. The privileges accorded to the Long Seridan people might eventually be transfereed to the proposed extension.

2.5 Privileges

The privileges accorded to the Long Seridan people in the Ulu Ubung were put in at the suggestion of Forestry staff rather than as a result of claims (ref: CD.907/G. Mulu/1-85a). There is no evidence that the area was traditionally hunted by anyone other than the Penan.

No privileges should be accorded, other than the general privilege of the Penan covering the whole area of the Park.

3 LUTUT

3.1 Boundaries

A small area in the headwaters of the Sungai Lutut between the Lutut and the Brunei border; it corresponds to three coups.

3.2 Reasons for exclusion from present Park

The original proposal for the Park (Sarawak Government Gazette, 21 May 1965) included the whole area between the S. Melinau and the Brunei border. This was excised at the insistence of Penghulu Baya Malang and S. Lutut became the new boundary.

3.3 Description

The proposed extension contains low hills on the Setap Shales with dipterocarp forest and kerangas. The slopes are steep and logging results in considerable erosion.

The strip is narrow, and the loggable area is reduced by the buffer zone along the Brunei border.

The strip separates the Park from a Nature Reserve in Brunei.

The forest has been logged, but steps are being taken to prevent the licensee from re-entering these three coupes.

3.4 Justification for the extension

i) Protection of the water supply of Kampong Batu Bungan, Park HQ and the private guesthouses along the Melinau; this is preferable to creating a buffer zone along the river since the strip is so narrow.

ii) The proposed boundary would be easier to enforce. The present boundary is not obvious, since the S. Lutut splits into several branches. Some logging has been done well inside the Park, extending into the Mentawai catchment.

iii) The interface between the Park and the contiguous Nature Reserve in Brunei would be substantially increased.

3.5 Privileges

No special privileges should be accorded for this small area. However, if the Penan of Batu Bungan are allowed to hunt and gather in Ulu Lutut, this area would be included.

APPENDIX 4 : INTRODUCTION OF ANIMALS TO THE PARK

On occasion, there are suggestions that animals should be introduced or reintroduced to the Park. These have included: (1) reintroduction of gibbons so that visitors can hear them singing; (2) introduction of orang-utans, both so the visitors can see them, and also as a solution to the problem of where to put confiscated orang-utans; (3) keeping a few animals in enclosures or cages for visitors to see, since it is often difficult to spot animals in the wild in the Park.

Introduction or reintroduction of animals to the Park in this or other ways must not be done under any circumstances. The reasons are (adapted from Caldecott and Kavanagh, 1983):

Unsuccessful release. Without proper care and reintroduction procedures, often taking weeks or months, released animals are likely to be panicked, disoriented and unhealthy. This means that they are stressed, likely to be injured or taken by predators, lost from their groups, or flee into unsuitable areas such as farmland or heavily hunted zones.

Genetic contamination of resident wild populations. If the animals come from anywhere other than the immediate area of Mulu, they might cause genetic contamination of resident wildlife populations. Animals vary genetically, often over short distances. These differences usually adapt them to their immediate environment. Contaminating indigenous animals with genes from elsewhere could reduce the fitness of the whole population.

Introduction of disease. Introduced animals have been stressed, and in close contact with humans and possibly other animals. They might have picked up diseases which they introduce into the wild population. If the diseases originated with humans, captive animals or animals from other areas, resident animals might have little resistance to that illness, so it could wipe out many animals. Thus, for the sake of releasing a few animals, a whole population is threatened.

Risk of introducing animals into unsuitable areas. If there are no animals of that species in the area already (e.g., orang-utans in Mulu), it leads to the question of why not? The most likely reasons are either: (i) that the habitat is unsuitable for some reason, in which case the introduced animals are unlikely to survive for long; or (ii) that they used to occur there but have been wiped out by hunting or some other factor. If that is the case, unless hunting pressure or other causal factors can be changed, the released animals will merely be a short-term, easy supply of meat for hunters.

Risk of exceeding the environmental carrying capacity for that species. In the wild, animals generally reproduce to a point where their numbers are limited by food, or by predators. If it is limited by food, introduction of more animals means there will be insufficient food for the larger population, so either the introduced animals, or resident ones, will eventually die. If it is limited by predators or some other source of mortality, introduction of more animals is unlikely to increase the total population in the long term. The only obvious exception is if the resident population has been severely reduced by hunting or disease, that has now been controlled, and animals are introduced to build up the population to viable levels.

Risk of ecological disruption. If that species is absent from the area, its introduction runs the very real risk of severe ecological disturbance, e.g., becoming pests, out-competing and eliminating competitors, preying on other species not adapted to appropriate defence, preying on nests and nestlings, or, in the case of large herbivores, having a significant effect on the vegetation, and thus on the community at large. Ecological relationships in rain forests are so complex that all the ramifications of such a change are not known until they happen, by which time it may be too late to control them.

Most or all of these risks are also faced if captive animals are held at the Park, since they can be a source of infection to wild animals, and also, eventually, some animals will inevitably escape. Thus, there are so many potential risks that they should not be considered for the Park. The only time that such procedures are appropriate are when a rare species has been eliminated from its former habitat (e.g., by hunting), there are no resident conspecifics left, and introduced animals can be guaranteed full protection. This does not apply for any known animals in Gunung Mulu National Park.

There is still the question that visitors expect to see animals when they visit Gunung Mulu. This is to a large extent a problem of interpretation - they do not realise how rare most animals are in rain forests, and how difficult it is to see them. Moreover, they do not know how to move quietly in the forest to maximize their chances of seeing animals; they often expect it to be like African safari parks, where the habitat and animals are totally different. Solutions to this problem, therefore, are largely educational, and include:

- encouraging travel organizers (private companies, TDC, STA etc.) to promote Gunung Mulu on what visitors can realistically expect to see, rather than on large numbers of animals which they are unlikely to encounter. Changing visitor expectations to realistic levels would help to eliminate disappointment. There are so many spectacular things that they can guarantee seeing in the Park that this should be straightforward;

- promoting what a rain forest is all about to visitors (e.g., rarity of animals, complexity of the system etc.). This can be done through slide shows, videos, introductory talks by Park guides and tour operators, and reading materials.

APPENDIX 5 : PROFESSIONAL ENTRY PERMITS

These are intended for professionals in the tourist industry such as tour agency guides, boat men and managers who enter the Park on a regular basis. At present, they enter the Park without a permit.

The permit would take the form of a laminated card with the name, I.C. number, agency and job description with a photograph of the permit holder. The cards would be issued by the Park after a formal interview and the completion of an application form. It will be valid for only half a year.

The following conditions would apply:

- Employment by a TDC registered agency
- Knowledge of the National Parks Ordinance and Regulations
- Given an undertaking to comply with the Ordinance and Regulations
- Attendance of a briefing
- A first aid certificate/life saving qualification or at least a good knowledge of first aid
- Agreement to help in a rescue or emergency and attendance of courses being held by Park staff.

(Form on following page)

GUNUNG MULU NATIONAL PARK

APPLICATION FOR PROFESSIONAL ENTRY PERMIT
* New application/renewal

Name:...

I.C. No.:...

Other names:..

Employer:...

Post: * Guide/ boatman / porter / cook / ....

Languages: English / Bahasa Malaysia / Penan only

First aid qualification:....................................

N.P. Briefing: By:...................... Date:................

Declaration by applicant:
To be completed during the interview
I am familiar with Sections 14 to 15I and 19 of the National Parks Ordinance and Regulations made thereunder and undertake:
(1) to respect the provisions of the Ordinance;
(2) to ensure that visitors respect them also;
(3) to report any infringement to a Park Officer as soon as possible;
(4) to assist Park staff in carrying out their duties.

Signature of applicant: ....

Signature of witness: ....

Name and position: ....

Declaration by employer:
(1) The applicant is a *full-time / part-time employee.
(2) I/we will inform the Park Warden if his/her employment ceases.
(3) I/we agree to release him/her to assist with any search or rescur operation in the Park and for up to four days per year for training purposes.
(4) The application is of good character and will comply with Park regulations and directives.

Signature of authorised person..............................

Full name and position......................................

Company chop:

GUNUNG MULU NATIONAL PARK

APPLICATION FOR PROFESSIONAL ENTRY PERMIT
* New application/renewal

Name:...

I.C. No.:...

Other names:..

Employer:...

Post: * Guide/ boatman / porter / cook / ....

Languages: English / Bahasa Malaysia / Penan only

First aid qualification:..................................

N.P. Briefing: By:....................... Date:................

Declaration by applicant:
To be completed during the interview
I am familiar with Sections 14 to 15I and 19 of the National Parks Ordinance and Regulations made thereunder and undertake:
(1) to respect the provisions of the Ordinance;
(2) to ensure that visitors respect them also;
(3) to report any infringement to a Park Officer as soon as possible;
(4) to assist Park staff in carrying out their duties.

Signature of applicant: ....

Signature of witness: ....

Name and position: ....

Declaration by employer:
(1) The applicant is a *full-time / part-time employee.
(2) I/we will inform the Park Warden if his/her employment ceases.
(3) I/we agree to release him/her to assist with any search or rescur operation in the Park and for up to four days per year for training purposes.
(4) The application is of good character and will comply with Park regulations and directives.

Signature of authorised person..............................

Full name and position......................................

Company chop:

APPENDIX 6

1991 Expenditure

Head S.35	Allocations for Miri	Total Expenditure by Mulu Park HQ
43. Personal Emoluments	$198,000.00	$ 49,020.50
44. Administration		
01 Uniform	$ 2,000.00	$ 882.00
02 Office Expenses	$ 5,000.00	$ 1,500.00
03 Stores & Equipment	$ 16,000.00	$ 11,274.60
45. Transport & Travelling	$205,000.00	$ 92,029.40
46. Printing & Stationery	$ 7,000.00	$ 2,000.00
47. Management N.P.		
01 Management of Boundaries	$ 40,000.00	$ 26,024.70
02 Maintenance of Paths & Bridges	$ 38,000.00	$ 9,890.00
03 Maintenance of Buildings	$ 20,000.00	$ 8,335.00
04 Casual Labour	$100,000.00	$ 24,818.35
50. Furnishing of Resthouse & Hostels	$ 28,000.00	$ 18,087.10

86-01 Tourism (Mulu)

Allocation	Total Expenditure
$ 367,860.00	$ 364,290.05

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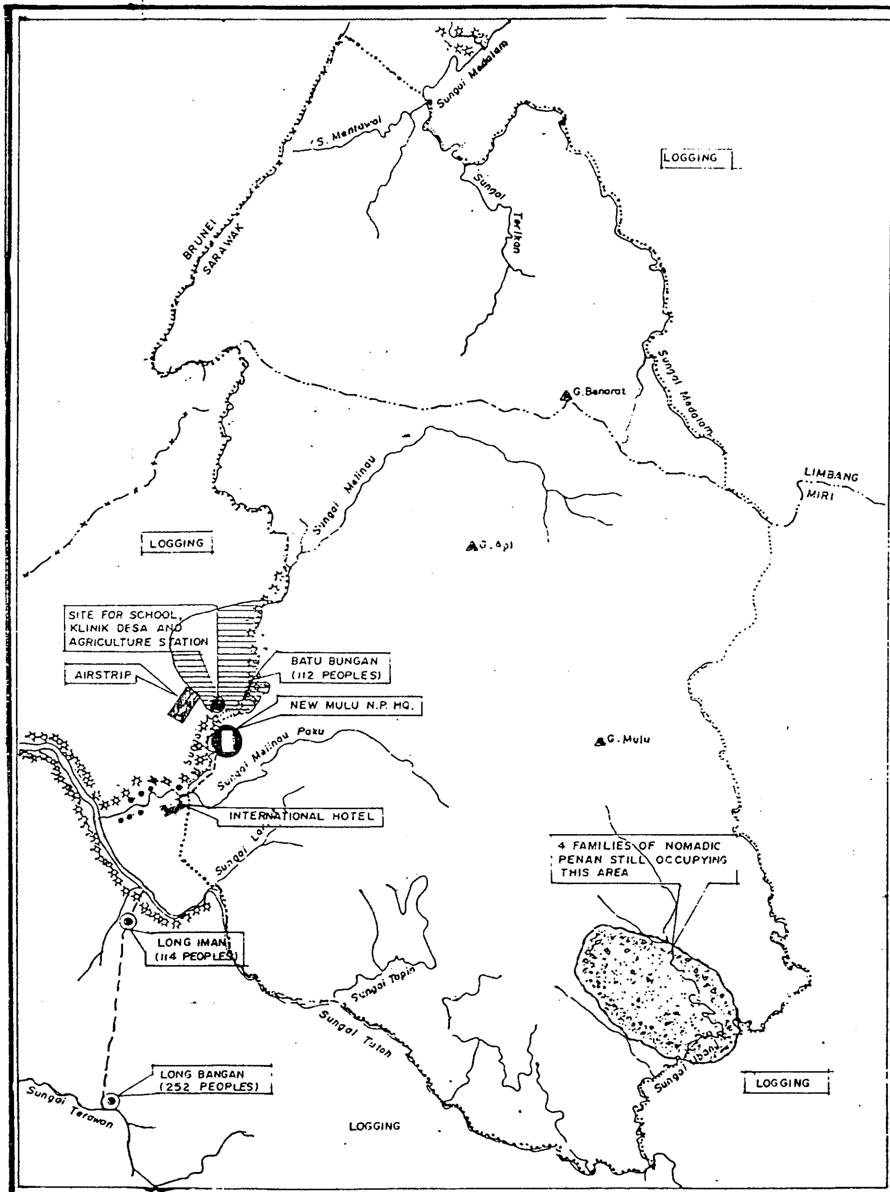


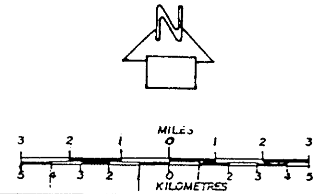


FIGURE No: 2

TITLE:

LAND USE OUTSIDE GUNUNG MULU NATIONAL PARK.

LEGEND:

- Park Boundary
- Farming
- Proposed Penan Reserve/Settlement Area.
- Existing Footpath for Improvement
- Site of Private Lodging House.

NATIONAL PARKS & WILDLIFE BRANCH,
FOREST DEPARTMENT,
SARAWAK.

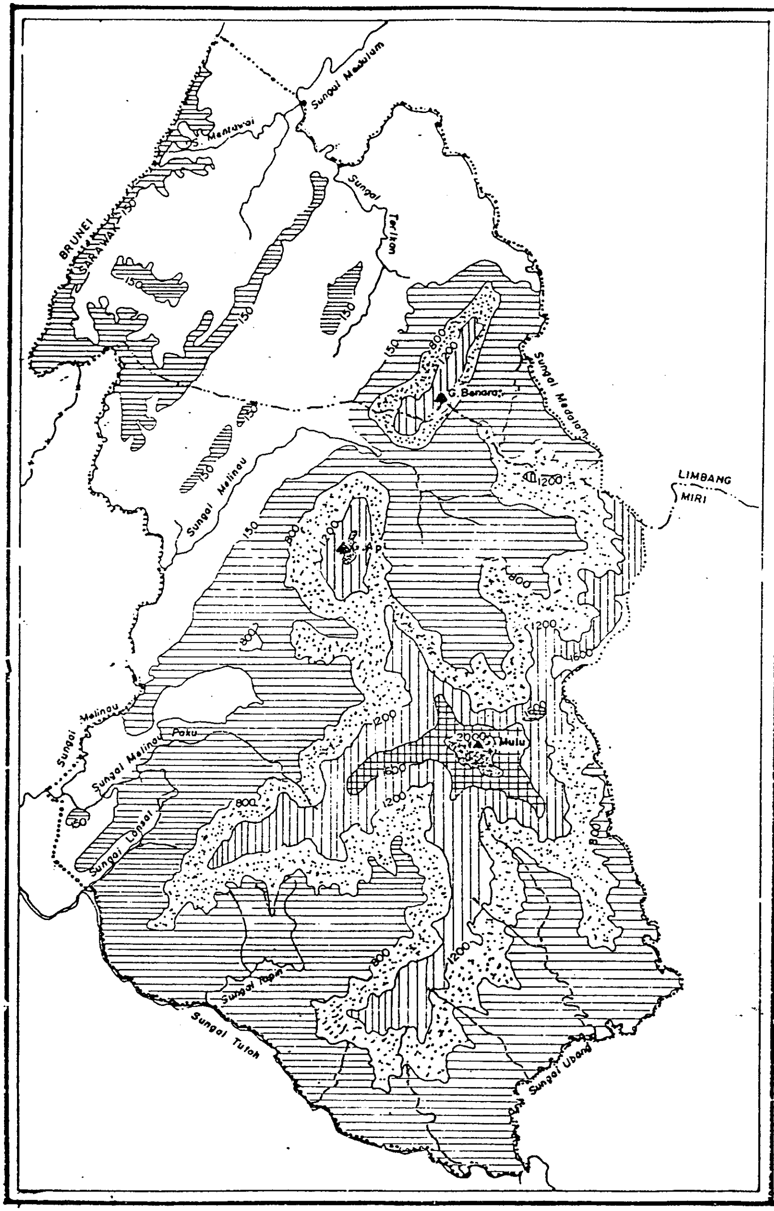


FIGURE No: 3

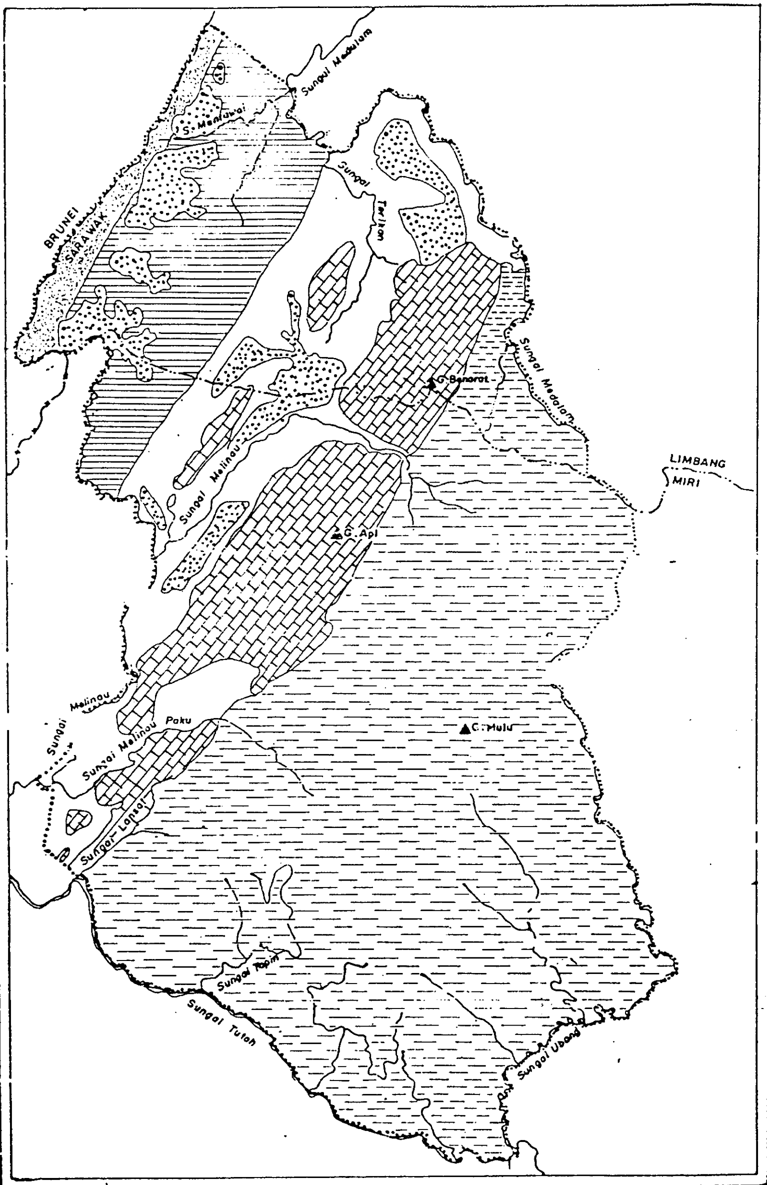
TITLE:

RELIEF.

LEGEND:

- 150 - 800 metres
- 800 - 1200 metres
- 1200 - 1600 metres
- 1600 - 2000 metres
- 2000 - 2400 metres
- 0 - 150 metres
- Political Boundary
- Park Boundary

NATIONAL PARKS & WILDLIFE BRANCH,
FOREST DEPARTMENT,
SARAWAK.



MILES
3 2 1 0 1 2 3
5 4 3 2 0 2 3 4 5
KILOMETRES

FIGURE No: 4

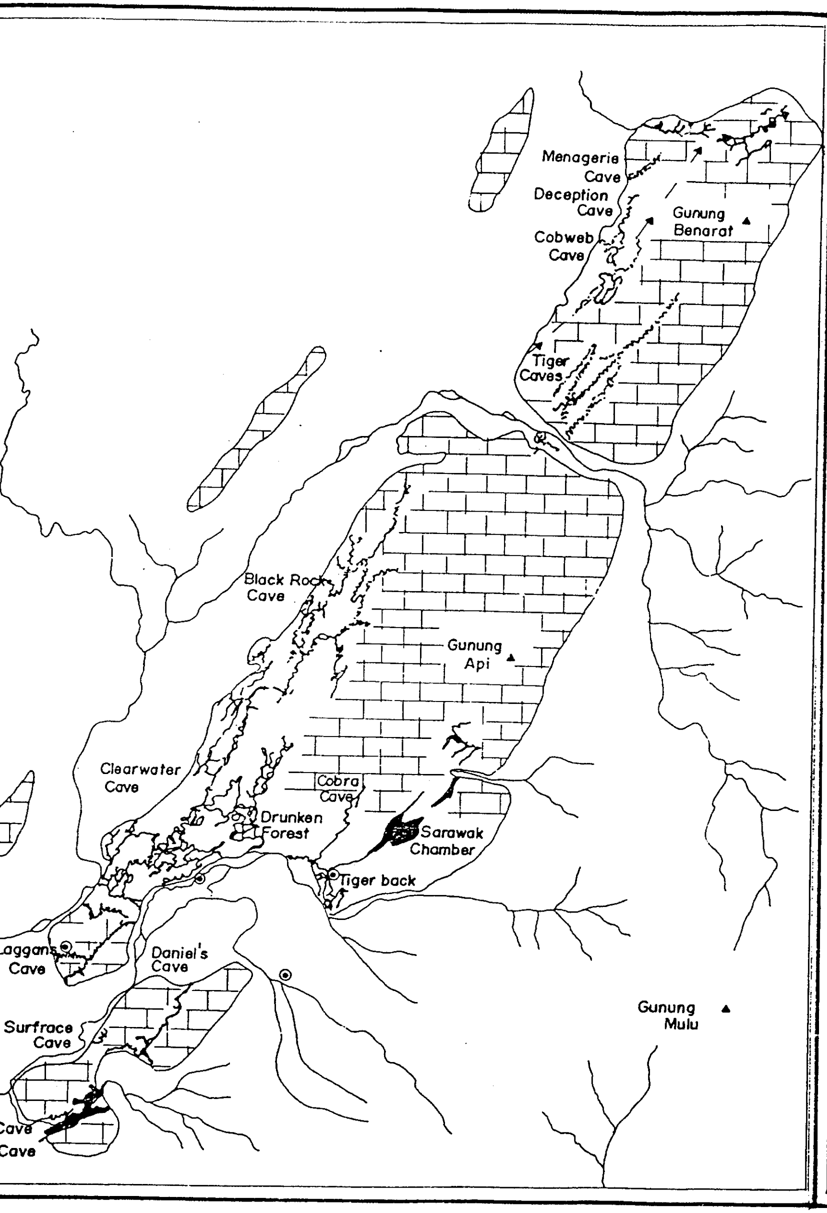
TITLE:

GEOLOGY

LEGEND:

- Alluvium
- Terrace
- Belait Formation
- Setap Formation
- Melinau Limestone
- Mulu Formation

NATIONAL PARKS & WILDLIFE BRANCH,
FOREST DEPARTMENT,
SARAWAK.



N

0 1 2 3 4 5
KILOMETRES

FIGURE No: 5

TITLE:

THE CAVES OF GUNUNG MULU NATIONAL PARK.

LEGEND:

[Limestone symbol]	Limestone
[Caves symbol]	Caves
[Camp symbol]	Camp

NATIONAL PARKS & WILDLIFE BRANCH,
FOREST DEPARTMENT,
SARAWAK.

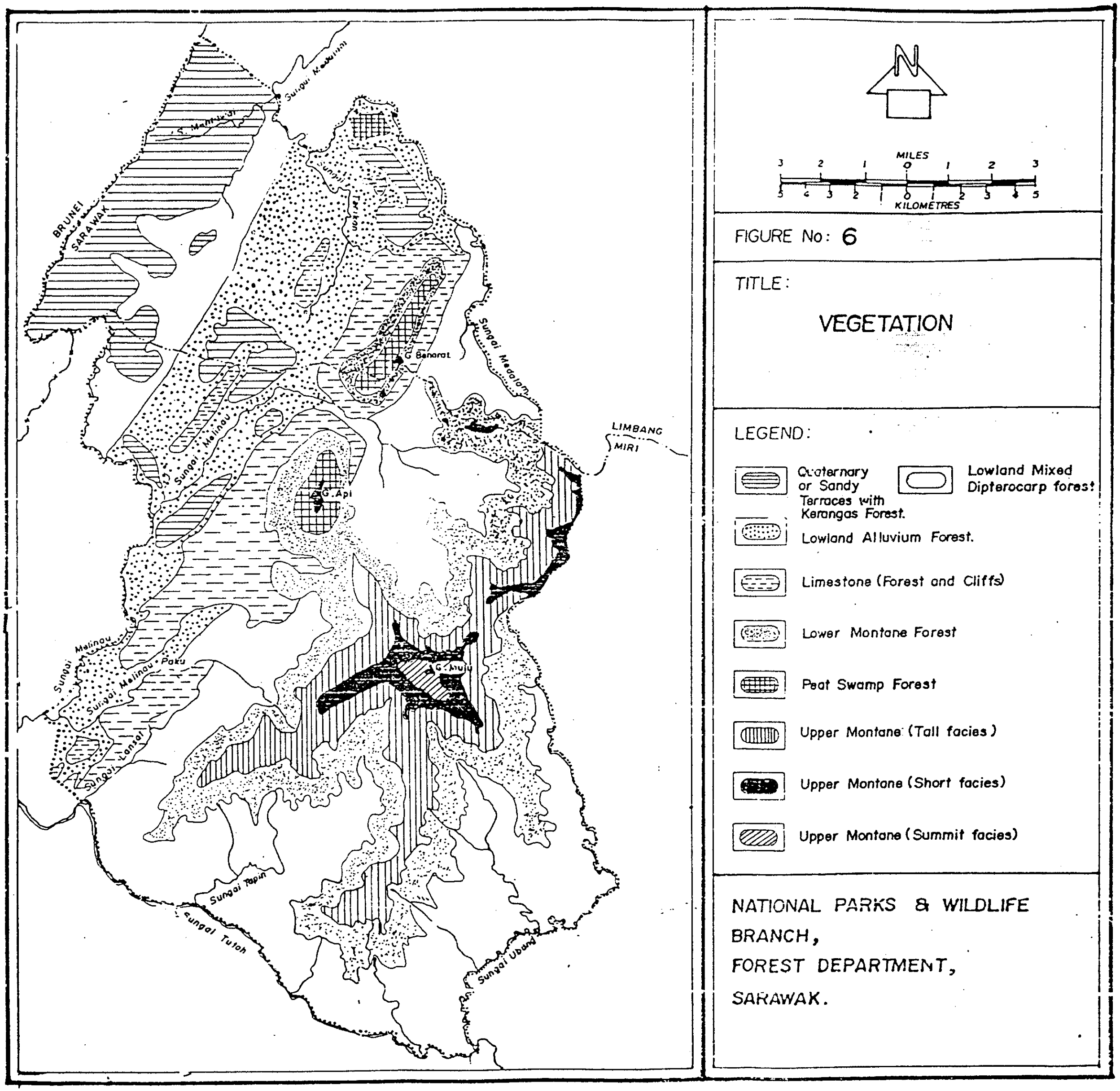
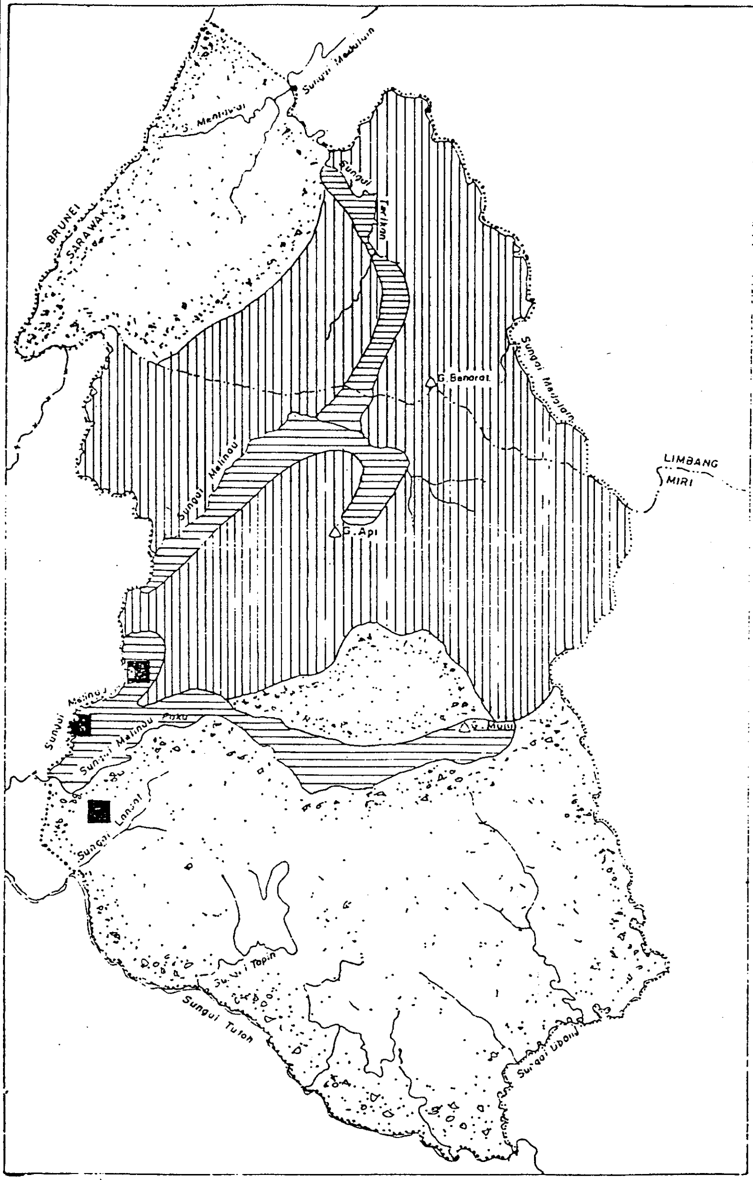


FIGURE No: 6

TITLE: VEGETATION



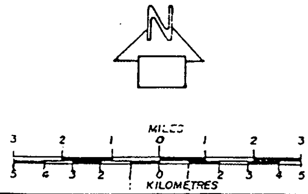


FIGURE No: 7

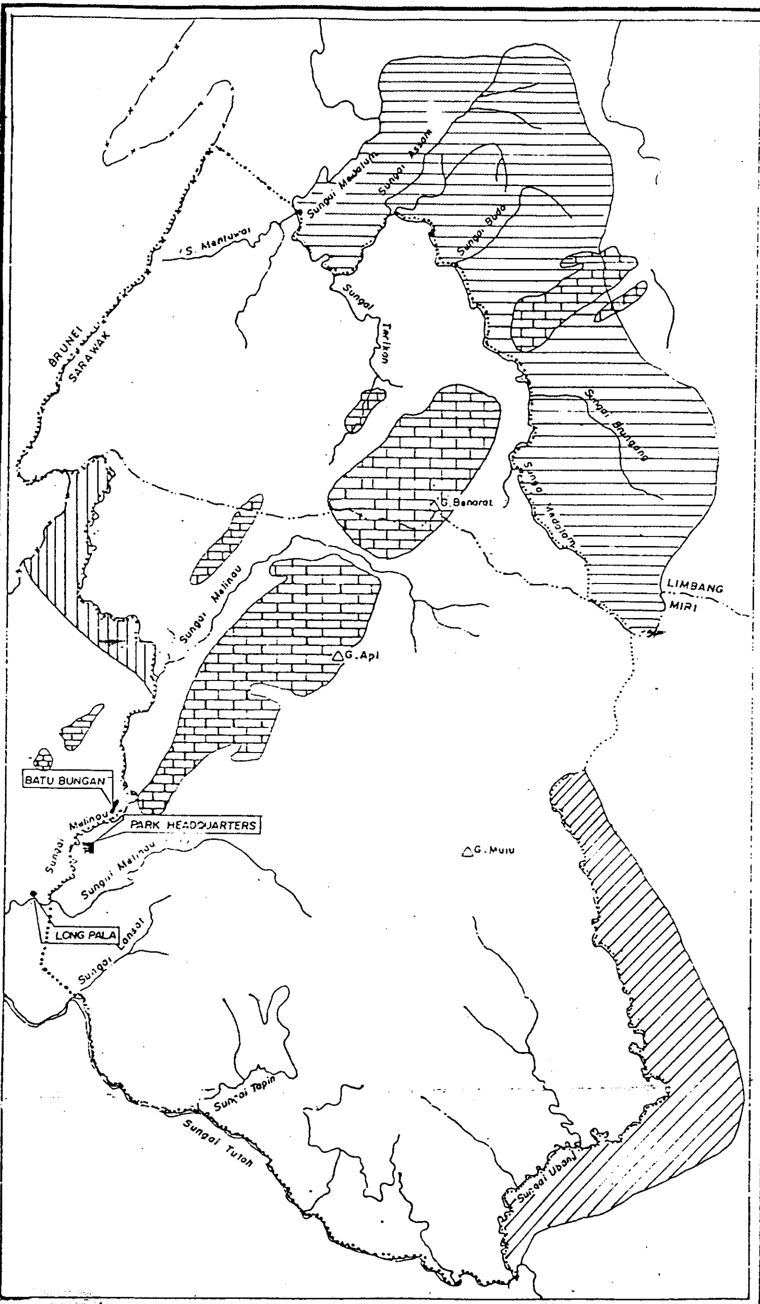
TITLE:

ZONATION PLAN

LEGEND:

- Heavy Density Usage
- Low Density Usage
- Traditional Use Zone
- Wilderness Zone

NATIONAL PARKS & WILDLIFE BRANCH,
FOREST DEPARTMENT,
SARAWAK.



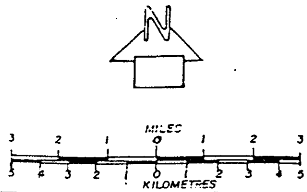


FIGURE No: 9

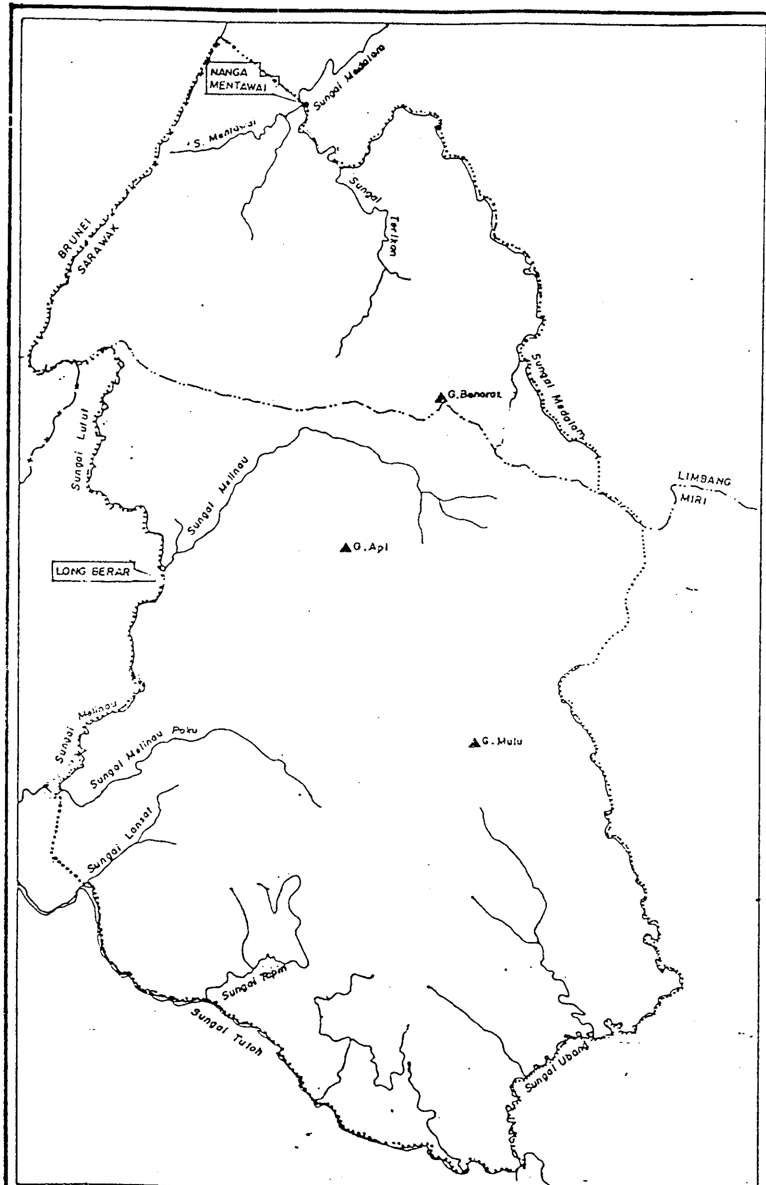
TITLE:

PROPOSED EXTENSIONS TO GUNUNG MULU NATIONAL PARK.

LEGEND:

- International Boundary
- Settlement
- Divisional Boundary
- Park Infrastructure
- Park Boundary
- Limestone Hills
- Medalam Extension (Proposed)
- Lutut Extension (Proposed)
- Ubung Extension (Proposed)
- Gunung Mulu National Park (1974)

NATIONAL PARKS & WILDLIFE BRANCH,
FOREST DEPARTMENT,
SARAWAK.



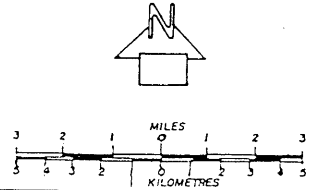


FIGURE No: 10

TITLE:

BOUNDARY OF GUNUNG MULU NATIONAL PARK.

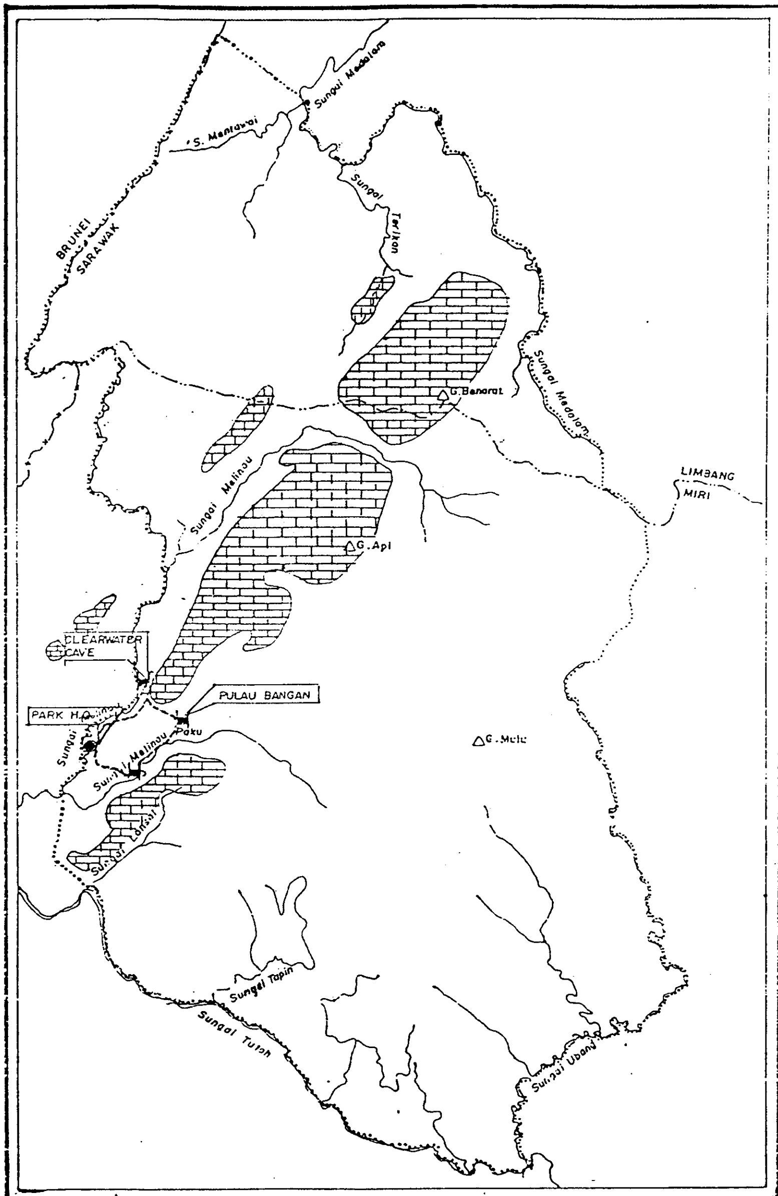
LEGEND:

Park Boundary

Divisional Boundary

International Boundary

NATIONAL PARKS & WILDLIFE BRANCH,
FOREST DEPARTMENT,
SARAWAK.



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MILES

KILOMETRES

FIGURE No: 11

TITLE:

PROPOSED TRAILS AND SHELTERS.

LEGEND:

Park Boundary

Proposed Trails

Proposed Day Shelters

NATIONAL PARKS & WILDLIFE BRANCH,
FOREST DEPARTMENT,
SARAWAK.

WORLD HERITAGE NOMINATION – IUCN TECHNICAL EVALUATION

GUNUNG MULU NATIONAL PARK (SARAWAK, MALAYSIA)

1. DOCUMENTATION

i) **IUCN/WCMC Data Sheet:** (18 references)

ii) **Additional Literature Consulted:** Meridith M. and J. Wooldridge. 1992. **Giant Caves of Borneo**. Tropical Press. Kuala Lumpur; IUCN-SSC 1998 Global Action Plan for Microchiroptean Bats. Final Draft; Vermeulen J. and T. Whitten. 1999. **Biodiversity and Cultural Property in the Management of Limestone Resources**. Lessons from East Asia. World Bank/IUCN; Braatz. S 1992. Conserving Biological Diversity: A Strategy for Protected Areas in Asia – Pacific Region. World Bank Technical Paper 193; Collins M. *et al* eds. **The Conservation Atlas of Tropical Forests** – Asia and Pacific; IUCN McNeely J. 1999. **Mobilising Broader Support for Asia's Biodiversity**. ADB; MacKinnon J. ed. 1997 **Protected Area Systems Review of the Indomalayan Realm**. ABC/WCMC; Hitchcock P. 1998. Post World Heritage Seminar Report on Mission to Malaysia; CIFOR/UNESCO 1999. **World Heritage Forests** – The World Heritage Convention as a Mechanism for Conserving Tropical Forest Biodiversity; Cubitt G. 1996. **Wild Malaysia**. New Holland; MacKinnon, K. *et. al*. 1996. **The Ecology of Kalimantan** Periplus; Mandis Roberts Consultants. 2000. Integrated Development and Management Plan. Inception Report; Waltham, T. 1997. Mulu. The Ultimate in Cavernous Karst. **Geology Today**. Nov/Dec; Waltham, T. 1995. The Pinnacle Karst of Gunung Api, Mulu, Sarawak. **Cave and Karst Science** 22(3); Brookfield, H. *et. al.* 1996. **In Place of the Forest: Environmental and Socio-Economic Transformation in Borneo**. UNU Press; MacKinnon, J. 1975. **Borneo**. Time-Life Books; Cleary M. and P. Eaton. 1992. **Borneo – Change and Development**, OUP; Hanbury-Tenison, R. 1982. **Mulu - The Rainforest**. Weidenfeld and Nicholson.

iii) **Consultations:** 17 external reviewers, officials from Sarawak Forest Department, Mandis Roberts Planning Consultants.

iv) **Field Visit:** J. Thorsell, January 2000

2. SUMMARY OF NATURAL VALUES

Gunung Mulu National Park (GMNP) on the island of Borneo protects a wide range of natural values within its 52,864 hectares (see Map 1). With an altitudinal range from 28m to the 2377m summit of Gunung Mulu, the park has 17 vegetation zones, primarily lowland rainforest (40% of the area) and montane rainforest (20% of the area). Some 3,500 species of vascular plants have been recorded including a high number of endemics found on limestone substrates. GMNP is considered to be one of the richest sites in the world for palms with 109 species of 20 genera identified. Eighty species of mammals and 270 species of birds (including 24 Borneon endemics) have been recorded. The cave fauna, including many trogloditic species, number over 200. The area also has many species of reptiles (55), amphibians (76), fish (48) and invertebrates (20,000+). The park also supports huge bat colonies (3 million wrinkled-lipped freetail bats inhabit Deer Cave alone) and cave swiflets (several million in one cave).

GMNP is not only important for this high biodiversity but also for its karst features. There are at least 295km of explored caves including some of the largest in the world. A range of cave types at different levels exist due to uplift during the late Pliocene to Pleistocene. The caves, which are concentrated in the Melinau limestone formation and on Gunung Api and are estimated to be at least 2-3 million years old. Sarawak Chamber, which is 600m x 415m and 80m high, is the largest known cave chamber in the world. There are some exceptional decorated speleothems with spectacular examples of argonite and calcite needles. Another outstanding karst feature in GMNP are the "pinnacles", 50m high sharp blades of rock that project through the rainforest canopy.

In sum, GMNP protects a substantial area of Borneo's primary tropical forest containing a high diversity of biota including many Borneon endemics and threatened species. The park also has a high concentration of large cave passages and chambers which in turn provide a major wildlife spectacle in terms of millions of cave swiftlets and bats. The area is roadless and has no permanent residents. Local Penans retain traditional hunting rights within the park.

3. COMPARISONS WITH OTHER AREAS

There are no natural World Heritage sites in the Borneo Biogeographic Province although Kinabalu in the neighbouring state of Sabah has also been nominated for review in 2000. There is some overlap in species between Kinabalu and GMNP, with the former being about 20% more species-rich in both flora and fauna. Kinabalu is very different geologically (i.e. a granite dome) and is much higher in elevation (4100m). Kinabalu does not have the extensive karst landscape of GMNP, however, nor any of the associated values that are found with karst. Both sites are very distinctive in their own right and are judged by most reviewers as the two most important conservation areas on the island of Borneo.

GMNP's karst features have been the focus of much research (notably through the Royal Geographical Society) and are generally accepted to be among the most spectacular in the world. Most other World Heritage karst and cave sites are in the temperate zone (e.g. Carlsbad, Mammoth, Castleguard (Canadian Rockies), Wulingyuan, Agglelek, Plitvice, Skokjan, Nahanni) and are very different from GMNP's rainforest karst setting. A relevant comparison is the Lorentz World Heritage site in Irian Jaya, inscribed in 1999, which includes major high altitude karst with what may be the largest underground river in the world. In terms of scale of its karst features, Lorentz is thus comparable to Mulu but differs in almost all other respects. There are also tropical karst features at Thung Yai Hua Kha Khaeng in Thailand and in the Puerto Princessa World Heritage Site in the Philippines, but these are on a much smaller scale with much less variety than found in GMNP. The Phong Nha/Hin Namno karst in Vietnam/Laos is another significant area but of lesser global significance than Mulu. There are many karst features in China as well but these are not tropical karst.

Perhaps the most similar karst area is to be found in several remote areas of Papua New Guinea's mountains. These areas are little known (Hindenburg Wall, Kanada, and Nakanai mountains) and none have any protective status. The pinnacle karst of Mulu is distinctive as well as being in both a more natural condition and a larger scale than the "Stone Forest" in Lunan, China. It is also different from the pinnacles found in Madagascar's Tsingy de Bemaraha World Heritage site in that Mulu is located on a steep mountain side and is not in the form of dissected plateaus created beneath major controlling bedding planes. Finally, there are clear contrasts between Mulu's caves that evolved on such a gigantic scale by a process of dissolution and those of Mammoth (USA) with its longer networks of smaller passages and Carlsbad (USA) which has evolved largely by hydrothermal processes.

In conclusion, the caves of Mulu are so long, large and complex, that Gunung Api can claim to be the most cavernous mountain in the world. It is also the most studied tropical karst area in the world and is without rival in terms of karst scenery and its setting in a mountainous rainforest.

Finally, the nomination notes the importance of the area for microchiropteran bats. This is certainly the case for the freetailed bat which number 3 million in Deer Cave alone. This is still much smaller than some *Tadaridu brasiliensis* colonies in South America, many of which number between 10 and 20 million. Likewise, there are other caves and parks with more bat species (e.g. Phong Nha). Comparative data for cave swiflets is not available but the numbers using Mulu are impressive. In sum, GMNP is indeed a significant habitat for bats and swiflets and is among the world's most important sites for protection of these species.

4. INTEGRITY

4.1 Boundaries

GMNP's limits are not ideal as full catchment protection is lacking (very important for some of the caves) and the very important caves in the adjacent Gunung Buda area are not included in the site. Fortunately, the State Government of Sarawak has recognised these deficiencies and the nomination document provides a map (see Map 2) indicating several extensions awaiting Ministerial approval. An additional 25,000ha. will eventually be added. Certainly the Gunung Buda area has substantial values and should be eventually incorporated into the site (particularly as it is currently being overharvested by swiflet nest collectors). These extensions will greatly contribute to the integrity of the Park.

GMNP also adjoins the Labi Forest Reserve in Brunei. This reserve contains extensive undisturbed lowland forest and effectively complements GMNP by adding to its integrity and habitat connectivity. IUCN suggests high-level discussions between the Governments of Sarawak and Brunei on the future co-operative protection of the two adjoining sites.

4.2 Management

GMNP has had two management plans prepared and a third is now in process (due September, 2000). Implementation has been effective with a park headquarters, field stations and a good system of trails and access to four "show caves". One constraint is adequate staffing. Currently there is only an acting park director and the level of staffing (47 people) and range of expertise compares unfavourably with Kinabalu in Sabah. Related to this constraint is the proposal to contract the management of the park out to a private body. Provision for concession management is made in Sarawak's 1998 Parks Act and, if structured properly, could result in a more effective management regime. The new management plan will contain details of the new arrangements.

In terms of legislation and institutional structures, national parks are defined as a concurrent function under the Malaysian constitution. Both state and federal levels of government have powers to pass legislation provided there is consultation. In Sarawak, national parks including Gunung Mulu are established and managed at the State level under a new Ordinance passed in 1998. Malaysia’s national park act does not apply to Sarawak (or Sabah) and it is thus the individual states that will carry the prime responsibility for the implementing the Convention in Malaysia (as is the case in other federal systems).

4.3 Threats

Local Penan and Berawan peoples were given privileges to hunt pig and deer in the park when it was gazetted. As much of the traditional nomadic hunting area outside the park has been affected by logging, hunting pressure on the park has intensified especially on larger animals such as pigs, primates and hornbills. GMNP has been intensively hunted over the past decade and a wildlife census is needed to determine sustainability levels.

A second serious threat comes from logging which is occurring around the park. Most of the forests have been cut up to the boundary rivers. Growing erosion has increased the silt-load of these rivers significantly altering the aquatic ecology. Further away from the park, the conversion of natural forests to oil palm plantations is inevitably leading to habitat loss for cave swiftlets and bats. These species are known to forage for insects beyond a 25km radius from their nesting sites. IUCN suggests that clear felling to create oil palm estates not be permitted within this distance from the GMNP boundary.

5. ADDITIONAL COMMENTS

With some 300 nomadic Penans using the GMNP for hunting and gathering and with two Penan settlements on the boundary of the park, various social issues need attention. These will be addressed in the management plan now being prepared.

6. APPLICATION OF WORLD HERITAGE CRITERIA

GMNP was nominated under all four natural criteria. In all assessments conducted by IUCN, WWF and other conservation organisations on the biological values of protected areas in Asia/Pacific, GMNP is ranked as one of the top priorities. Other reviews of karst features also mention Mulu as one of the most outstanding in the world. With its combination of many natural values, GMNP is a clear candidate for inscription on the World Heritage List on the basis of all four natural criteria:

Criterion (i): Earth’s history and geological features

The concentration of caves in Mulu's Melinau Formation with its geomorphic and structural characteristics are an outstanding resource which allows a greater understanding of earth's history. The caves of Mulu are important for their classic features of underground geomorphology, notably the sediment sequence and the layered sequences of wall notches that demonstrate an evolutionary history of more than 1.5 million years. This exceptionally long period makes the caves a valuable data source on geo-climatic fluctuations during the Pleistocene. The giant doline of the "Garden of Eden" is a massive expression of karstic collapse whose proximity to the nearby Sarawak Chamber (the world's largest) offers one of the world's finest examples of the collapse process in Karstic terrain. Also of significance are the foot caves found around the base of the limestone mountains which demonstrate the processes of lateral planation in a karst environment. IUCN considers that the nominated site meets this criterion.

Criterion (ii): Ecological Processes

GMNP provides outstanding scientific opportunities to study theories on the origins of cave faunas. The food webs of Mulu's caves and the large-scale transfer of food energy from forest to caves by bats and swiftlets is an exceptionally well-studied process here. Many of Mulu's troglodytes belong to very ancient groups which have largely disappeared from the modern land surface and are now represented by a few widely scattered species. These evolutionary processes in response to tectonic change are on-going. IUCN considers that the nominated site meets this criterion.

Criterion (iii): Superlative natural phenomena or natural beauty and aesthetic importance

With its deeply-incised canyons, wild rivers, rainforest-covered mountains, spectacular limestone pinnacles, cave passages and decorations, Mulu has outstanding scenic values. The natural phenomenon of millions of bats and swiflets leaving and entering the caves is a superlative wildlife spectacle as is the less-easily appreciated life of the invertebrate world in the caves. IUCN considers that the nominated site meets this criterion.

Criterion (iv): Biodiversity and threatened species

GMNP also provides significant natural habitat for a wide range of plant and animal diversity both above and below ground. Its lowland and montane forests are botanically-rich in species and high in endemism. Mulu is one of the richest sites in the world for palm species and assumes greater importance in perspective of the transformation of much of Borneo's forests. The park also hosts one of the highest number of bat species (28) and populations in the region as well as a exceptionally diverse range of troglobitic species. IUCN considers that the nominated site meets this criterion.

7. RECOMMENDATION

The Bureau noted that GMNP is considered by IUCN to meet natural criteria i, ii, iii and iv. However, it decided that the nomination be referred back to the State Party for clarification of the following issues:

- progress with the gazettement process to incorporate the three extensions referred to in the nomination;
- action to strengthen management capacity in the park;
- recognition of the need to minimise impacts of logging activities around the park and the effect of clear-felling on cave swiftlet and bat populations; and
- assurance that the new management plan addresses issues relating to local peoples' use of and benefits from the park as well as the new contractual arrangements for management of the park.

The Bureau furthermore drew the attention of the State Party the important buffer and corridor function of the adjacent protected forests in the Labi Hills in Brunei and noted that this country had not yet signed the Convention.

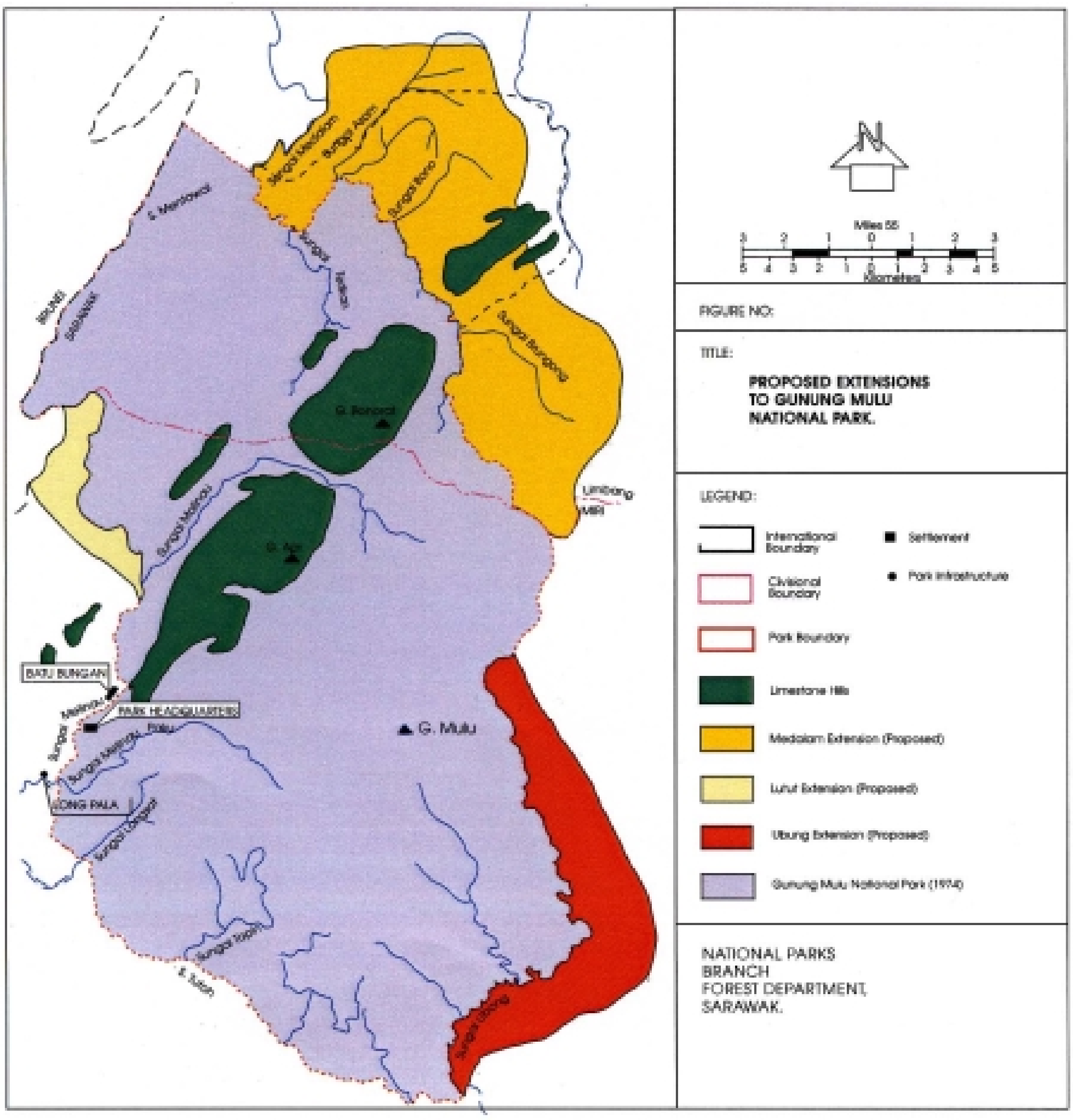
Following the twenty-fourth ordinary session of the Bureau, the Centre received a letter from the State Party on 20 September 2000. This letter notes that two extensions (10,787ha) have been approved by the State government and that two other proposed extensions (34,960ha) have been submitted to the state government for approval. IUCN notes that the area of gazetted and proposed extensions (45,747ha) is greater than the area of extensions envisaged in the original nomination (circa 25,000ha) and that these areas are not formally included in the current nomination.

The letter notes that an Integrated Development and Management Plan for GMNP was in process (completed in October 2000). IUCN has reviewed the plan which gives high priority to management capacity issues and addresses benefits to the local community and activities outside the park.

IUCN considers that the response from the Malaysian authorities and the new management plan very satisfactorily address the Bureau's concerns over integrity. GMNP should thus be **inscribed** on the basis of all four natural criteria.

The Committee may wish to commend the State Party for preparation of the Integrated Development and Management Plan and the progress with approving the extensions to the park. The Committee may also wish to invite the State Party's to review the potential of the recently gazetted extensions as future additions to the World Heritage area.

Map 1: Location Map – Gunung Mulu National Park



Map 2: Site Map – Gunung Mulu National Park

CANDIDATURE AU PATRIMOINE MONDIAL - ÉVALUATION TECHNIQUE UICN

PARC NATIONAL DU GUNUNG MULU (SARAWAK, MALAISIE)

1. DOCUMENTATION

i) **Fiches techniques UICN/WCMC** (18 références)

ii) **Littérature consultée:** Meridith M. and J. Wooldridge. 1992. **Giant Caves of Borneo**. Tropical Press. Kuala Lumpur; IUCN-SSC 1998 Global Action Plan for Microchiroptean Bats. Final Draft; Vermeulen J. and T. Whitten. 1999. **Biodiversity and Cultural Property in the Management of Limestone Resources**. Lessons from East Asia. World Bank/IUCN; Braatz. S 1992. Conserving Biological Diversity: A Strategy for Protected Areas in Asia – Pacific Region. World Bank Technical Paper 193; Collins M. *et al* eds. **The Conservation Atlas of Tropical Forests –** Asia and Pacific; IUCN McNeely J. 1999. **Mobilising Broader Support for Asia's Biodiversity**. ADB; MacKinnon J. ed. 1997 **Protected Area Systems Review of the Indomalayan Realm**. ABC/WCMC; Hitchcock P. 1998. Post World Heritage Seminar Report on Mission to Malaysia; CIFOR/UNESCO 1999. **World Heritage Forests –** The World Heritage Convention as a Mechanism for Conserving Tropical Forest Biodiversity; Cubitt G. 1996. **Wild Malaysia**. New Holland; Mackinnon, K. *et. al*. 1996. **The Ecology of Kalimantan** Periplus; Mandis Roberts Consultants. 2000. Integrated Development and Management Plan. Inception Report; Waltham, T. 1997. Mulu. The Ultimate in Cavernous Karst. **Geology Today**. Nov/Dec; Waltham, T. 1995. The Pinnacle Karst of Gunung Api, Mulu, Sarawak. **Cave and Karst Science** 22(3); Brookfield, H. *et. al.* 1996. **In Place of the Forest: Environmental and Socio-Economic Transformation in Borneo**. UNU Press; MacKinnon, J. 1975. **Borneo**. Time-Life Books; Cleary M. and P. Eaton. 1992. **Borneo – Change and Development**, OUP; Hanbury-Tenison, R. 1982. **Mulu - The Rainforest**. Weidenfeld and Nicholson.

iii) **Consultations:** 17 évaluateurs indépendants, fonctionnaires du Département des forêts du Sarawak; Mandis Roberts Planning Consultants.

iv) **Visite du site:** Jim Thorsell, janvier 2000.

2. RÉSUMÉ DES CARACTÉRISTIQUES NATURELLES

Le Parc national du Gunung Mulu (PNGM), sur l'île de Bornéo, protège, dans ses 52 864 hectares, des caractéristiques naturelles extrêmement diverses. Avec un gradient altitudinal de 28 mètres à 2377 mètres au sommet du Gunung Mulu, le parc contient 17 zones de végétation, essentiellement des forêts ombrophiles de plaine (40% de la superficie) et des forêts ombrophiles de montagne (20% de la superficie). On y a répertorié environ 3500 espèces de plantes vasculaires dont un grand nombre d'espèces endémiques poussant sur des substrats calcaires. Le PNGM est considéré comme l'un des sites les plus riches du monde pour les palmiers, avec 109 espèces de 20 genres décrits. Quatre-vingt espèces de mammifères et 270 espèces d'oiseaux (y compris 24 espèces endémiques de Bornéo) ont été enregistrées. La faune carvernicole, avec de nombreuses espèces troglodytes comprend plus de 200 espèces. La région possède aussi de nombreuses espèces de reptiles (55), d'amphibiens (76), de poissons (48) et d'invertébrés (plus de 20 0000). Il y a aussi dans le parc d'immenses colonies de chauves-souris (dans la «grotte du Cerf» uniquement, il y a 3 millions de molosses) et de salanganes (plusieurs millions dans une seule grotte).

Le PNGM n'est pas seulement important pour cette riche diversité biologique mais présente aussi des caractéristiques karstiques avec au moins 295 kilomètres de grottes explorées dont certaines des plus grandes du monde. En raison du relèvement qui a eu lieu entre la fin du Pliocène et le Pléistocène, on trouve différents types de grottes à différents niveaux. Ces grottes, concentrées dans la formation calcaire de Melinau et sur Gunung Api, dateraient de deux à trois millions d'année au moins. La Salle du Sarawak, mesurant 600 m x 415 m et 80 m de haut, est la plus grande salle souterraine connue au monde. On y trouve des spéléothèmes décorés exceptionnels et des exemples spectaculaires d'aiguilles d'aragonite et de calcite. Les pinacles, lames rocheuses acérées de 50 mètres de haut qui déchirent la canopée de la forêt ombrophile, sont une autre caractéristique karstique exceptionnelle du PNGM.

En résumé, le PNGM protège une grande proportion de la forêt tropicale primaire de Bornéo contenant une flore et une faune très diverses, y compris de nombreuses espèces menacées endémiques de Bornéo. Le parc présente aussi une forte concentration de grands passages et salles souterraines qui offrent à eux seuls, un spectacle sauvage extraordinaire avec les millions de salanganes et de chauves-souris que l'on peut y voir. Il n'y a pas de routes dans la région et pas de résidents permanents. Les Penan, population locale, conservent leurs droits de chasse traditionnels dans le parc.

3. COMPARAISON AVEC D'AUTRES AIRES PROTÉGÉES

Il n'y a pas de bien naturel du patrimoine mondial dans la Province biogéographique de Bornéo mais le mont Kinabalu, dans l'État voisin du Sabah, est également proposé pour inscription en 2000. Certaines espèces sont communes à Kinabalu et au PNGM, la flore et la faune du premier étant environ 20% plus riches en espèce. Kinabalu est très différent du point de vue géologique (c'est un dôme granitique) et beaucoup plus haut (4100 mètres). Il ne présente cependant pas les vastes paysages karstiques du PNGM, et aucune des valeurs associées au karst. Les deux sites sont très différents et sont considérés par la plupart des évaluateurs comme les deux régions les plus importantes pour la conservation de la nature sur l'île de Bornéo.

Les éléments karstiques du PNGM ont fait l'objet de travaux de recherche intenses (notamment par la Royal Geographical Society) et sont généralement considérés comme parmi les plus spectaculaires du monde. La plupart des autres biens karstiques et cavernicoles du patrimoine mondial, dans la zone tempérée (par exemple, Carlsbad, Mammoth, Castleguard (Rocheuses canadiennes), Wulingyuan, Aggtelek, Plitvice, Skokjan, Nahanni) sont très différents du PNGM dont le paysage karstique est serti dans la forêt tropicale ombrophile. La comparaison la plus réaliste serait avec le Bien du patrimoine mondial du Parc de Lorentz en Irian Jaya, inscrit en 1999, qui présente d'importantes caractéristiques karstiques de haute altitude avec, peut-être, la plus grande rivière souterraine du monde. Du point de vue de l'échelle des caractéristiques karstiques, Lorentz est comparable à Mulu mais en diffère à presque tous les autres égards. On trouve aussi des caractéristiques de karst tropical à Thung Yai Hua Kha Khaeng, en Thaïlande et dans le Bien du patrimoine mondial de Puerto Princessa, aux Philippines mais l'échelle est bien moindre et la diversité beaucoup moins grande que celle du PNGM. Le karst de Phong Nha/Hin Namno, au Viet Nam et au Laos, est une autre région intéressante mais d'importance mondiale inférieure à celle de Mulu. Il y a de nombreuses caractéristiques karstiques en Chine également, mais il ne s'agit pas de karst tropical.

La région karstique la plus semblable se trouve peut-être dans plusieurs aires reculées des montagnes de Papouasie-Nouvelle-Guinée qui sont peu connues (Hindenburg Wall, Kanada et les montagnes de Nakanai) et non protégées. Le karst à pinacles de Mulu se distingue de celui de la Forêt de pierre de Lunan, en Chine. En outre, il est plus vaste et dans un état plus naturel. Il est également différent des pinacles que l'on trouve dans le Bien du patrimoine mondial de Tsingy de Bemaraha, à Madagascar car il est adossé à une grande montagne et non sous forme de plateau découpé créé au-dessous de plans de litage principaux. Enfin, le contraste est net entre les grottes de Mulu qui ont évolué sur une échelle aussi gigantesque, par un processus de dissolution, et celles de Mammoth (États-Unis) qui possède des réseaux plus longs de petits passages et de Carlsbad (États-Unis) qui a essentiellement évolué grâce à des processus hydrothermiques.

En conclusion, les grottes de Mulu sont si longues, si grandes et si complexes que Gunung Api peut prétendre au titre de montagne la plus «caverneuse» du monde. C'est également la région karstique tropicale la plus étudiée au monde et son paysage karstique serti dans une forêt ombrophile de montagne est sans rival.

Enfin, la proposition note l'importance de la région pour les microchiroptères. C'est certainement le cas pour les molosses, avec 3 millions de spécimens dans la «grotte du Cerf» uniquement. La colonie est cependant beaucoup plus petite que certaines colonies de *Tadaridu brasiliensis* d'Amérique du Sud qui comptent souvent 10 à 20 millions de spécimens et il y a d'autres grottes et parcs qui contiennent davantage d'espèces de chauves-souris (par exemple Phong-Nha). Il n'y a pas de données comparatives pour les salanganes mais le nombre présent à Mulu est impressionnant. En résumé, le PNGM est, de toute évidence, un habitat important pour les chauves-souris et les salanganes et l'un des sites les plus importants du monde pour la protection de ces espèces.

4. INTÉGRITÉ

4.1. Limites

Les limites du PNGM ne sont pas idéales car l'ensemble du bassin versant n'est pas protégé (c'est très important pour certaines des grottes) et les grottes très importantes de la région limitrophe du Gunung Buda ne sont pas comprises dans le site. Heureusement, le gouvernement de l'État du Sarawak a reconnu ces lacunes et le dossier de la proposition contient une carte (ci-jointe) qui indique plusieurs extensions qui attendent l'approbation du ministère. Au bout du compte, 25 000 hectares supplémentaires seront ajoutés. Il est clair que les valeurs de Gunung Buda sont importantes et que cette région devrait être finalement incorporée dans le site (notamment, parce qu'elle est actuellement surexploitée par les ramasseurs de nids de salanganes). Toutes ces extensions contribueront de manière significative à l'intégrité du parc.

En outre, le PNGM est contigu à la Réserve forestière de Labi, au Brunéi Darussalam, qui contient de vastes forêts de plaine non perturbées complétant le PNGM, renforçant son intégrité et la continuité des biotopes. L'UICN suggère que les gouvernements du Sarawak et du Brunéi Darussalam se consultent pour définir la protection en coopération des deux sites limitrophes.

4.2. Gestion

Deux plans de gestion ont déjà été préparés pour le PNGM et un troisième est en préparation (il devrait être publié en septembre 2000). L'application des plans de gestion a été efficace: il y a un siège pour l'administration du parc, des postes de terrain et un bon réseau de sentiers donnant accès à quatre «grottes de démonstration». Un des problèmes concerne les effectifs du personnel: il n'y a, actuellement, qu'un directeur du parc par intérim et le personnel, tant par le nombre (47 personnes) que par les compétences n'est pas comparable à celui du Kinabalu, au Sabah. À ce propos, il est envisagé de confier la gestion du parc sous contrat à un organisme privé. La Loi du Sarawak sur les parcs (1998) prévoit la sous-traitance de la gestion et, avec les structures appropriées, le régime de gestion pourrait être plus efficace. Le nouveau plan de gestion décrira les nouvelles dispositions.

Du point de vue de la législation et des structures institutionnelles, les parcs nationaux font l'objet d'une juridiction conjointe au titre de la constitution malaisienne. L'État et le gouvernement fédéral ont le pouvoir de promulguer des lois à condition de se consulter. Au Sarawak, les parcs nationaux, y compris Gunung Mulu, sont créés et gérés au niveau de l'État dans le cadre d'une nouvelle ordonnance de 1998. La loi sur les parcs nationaux de la Malaisie ne s'applique pas au Sarawak (ni au Sabah) et c'est donc le gouvernement de l'État qui sera principalement responsable de la mise en œuvre de la Convention en Malaisie (comme c'est le cas dans d'autres systèmes fédéraux).

4.3. Menaces

Les populations locales Penan et Berawan ont obtenu le privilège de pouvoir chasser les suidés et les cervidés dans le parc au moment où celui-ci a été classé. La plupart des régions où se pratique une chasse nomade traditionnelle à l'extérieur du parc ont été affectées par l'exploitation du bois et, en conséquence, les pressions de la chasse se sont intensifiées sur le parc, et notamment sur les animaux de plus grande taille tels que les suidés, les primates et les calaos. Depuis 10 ans, la chasse est intense dans le PNGM et il serait bon de réaliser un recensement de la faune sauvage pour déterminer la capacité de charge.

L'exploitation du bois autour du parc est une deuxième menace grave. La plupart des forêts ont été coupées jusqu'aux rivières qui tracent les limites. L'érosion croissante a augmenté la charge sédimentaire dans ces rivières et modifié de manière significative l'écologie aquatique. Plus loin du parc, la transformation de forêts naturelles en plantations de palmiers à huile entraîne inévitablement une perte d'habitat pour les salanganes et les chauves-souris. On sait, en effet, que ces espèces chassent des insectes dans un rayon de plus de 25 kilomètres autour de leur lieu de nidification. L'UICN propose d'interdire la coupe à blanc aux fins de création de plantations de palmiers à huile sur cette distance à partir des limites du PNGM.

5. AUTRES COMMENTAIRES

Étant donné qu'il y a environ 300 Penan nomades qui utilisent le parc pour la chasse et la cueillette et deux villages penans sur les limites du parc, différentes questions sociales doivent être réglées. Elles seront traitées dans le plan de gestion en préparation.

6. APPLICATION DES CRITÈRES DU PATRIMOINE MONDIAL

Les quatres critères naturels sont invoqués pour justifier l'inscription du PNGM. Dans toutes les évaluations menées par l'UICN, le WWF et d'autres organisations de conservation sur les valeurs biologiques des aires protégées de l'Asie et du Pacifique, le PNGM apparaît comme l'une des principales priorités. D'autres évaluations des caractéristiques karstiques mentionnent aussi Mulu comme l'une des régions les plus exceptionnelles du monde. Avec cette association de nombreuses valeurs naturelles, le PNGM est un excellent candidat à l'inscription sur la Liste du patrimoine mondial sur la base des quatre critères naturels:

Critère (i): histoire de la terre et processus géologiques

La concentration des grottes de la formation Melinau de Mulu, avec ses caractéristiques structurelles et géomorphologiques, est une ressource exceptionnelle qui améliore considérablement la compréhension de l'histoire de la Terre. Les grottes de Mulu sont importantes pour les caractéristiques classiques de la géomorphologie souterraine, notamment la séquence de sédiments et les séquences d'encoches en couches qui illustrent une histoire évolutionnaire de plus de 1,5 million d'années. La période exceptionnellement longue fait de ces grottes une source de données précieuses sur les fluctuations géoclimatiques du Pléistocène.

La doline géante du «Jardin d'Éden» est l'expression massive d'un effondrement karstique dont la proximité à la Salle du Sarawak (la plus grande du monde) offre un des meilleurs exemples au monde du processus d'effondrement en terrain karstique. Les grottes qui se trouvent à la base des montagnes calcaires sont également importantes car elles illustrent des processus d'aplanissement latéral en milieu karstique. <u>L'UICN considère que le site proposé remplit ce critère.</u>

Critère (ii): processus écologiques

Le PNGM offre à la science l'occasion exceptionnelle d'étudier les théories de l'origine des faunes cavernicoles. Les chaînes alimentaires des grottes de Mulu et le transfert, à grande échelle, d'énergie alimentaire des forêts vers les grottes par les chauves-souris et les salanganes sont des processus exceptionnellement bien étudiés ici. Bien des troglodytes de Mulu appartiennent à de très anciens groupes qui ont essentiellement disparu de la surface de la Terre et ne sont plus aujourd'hui représentés que par quelques espèces très dispersées. Ces processus évolutionnaires, en réponse aux changements tectoniques, sont permanents. <u>L'UICN considère que le site proposé remplit ce critère.</u>

Critère (iii): phénomènes naturels éminemment remarquables ou de beauté exceptionnelle

Avec ses canyons profondément incisés, ses rivières sauvages, ses montagnes couvertes de forêts ombrophiles, ses pinacles calcaires spectaculaires, ses passages souterrains et les décorations des grottes, Mulu présente des valeurs paysagères exceptionnelles. Le phénomène naturel que constituent les millions de chauves-souris et de salanganes entrant et sortant des grottes est un spectacle vivant exceptionnel, tout comme la vie plus difficile à apprécier du monde invertébré des grottes. <u>L'UICN considère que le site proposé remplit ce critère.</u>

Critère (iv): diversité biologique et espèces menacées

Le PNGM fournit un habitat naturel important à une grande diversité de plantes et d'animaux vivant au-dessus et au-dessous du sol. Les forêts de plaine et de montagne sont riches en espèces et en endémisme. Mulu est un des sites les plus riches du monde pour les espèces de palmiers et a d'autant plus d'importance quand on considère la transformation d'une bonne partie des forêts de Bornéo. Le parc abrite également le plus grand nombre d'espèces (28) et de populations de chauves-souris dans la région ainsi qu'une gamme d'espèces troglobies à la diversité exceptionnelle. <u>L'UICN considère que le site proposé remplit ce critère.</u>

7. RECOMMANDATION

Le Bureau note que le PNGM est considéré par l'UICN comme satisfaisant aux critères naturels i, ii, iii et iv. Toutefois, il décide de **renvoyer** la proposition à l'État partie afin d'obtenir des précisions sur les points suivants :

- les progrès accomplis en ce qui concerne le processus de classement visant à intégrer les trois extensions dans la proposition;
- les mesures prises pour renforcer la capacité de gestion dans le parc;
- la reconnaissance de la nécessité d'atténuer les impacts des activités d'exploitation du bois autour du parc et l'effet de la coupe à blanc sur les populations de salanganes et de chauves-souris;
- l'assurance que le nouveau plan de gestion tiendra compte des questions relatives à l'utilisation du parc et au partage des avantages issus du parc avec les populations locales ainsi que des nouvelles dispositions contractuelles pour la gestion du parc.

Le Bureau attire aussi l'attention de l'État partie sur la fonction importante de tampon et de corridor que jouent les forêts protégées adjacentes, dans les collines Labi, au Brunéi, et note que cet Etat n'a pas encore signé la Convention.

A la suite de la vingt-quatrième session ordinaire du Bureau, le Centre a reçu le 20 septembre 2000 une lettre de l'Etat partie. Cette lettre note que deux extensions (10 787 hectares) ont été approuvées par le gouvernement de l'Etat et que deux autres extensions proposées (34 960 hectares) ont été soumises au gouvernement pour approbation. L'UICN note que la superficie des extensions classées et proposées (45747 hectares) est supérieure à celle des extensions envisagées dans la proposition initiale (env. 25 000 hectares) et que ces aires ne sont pas incluses formellement dans la proposition actuelle.

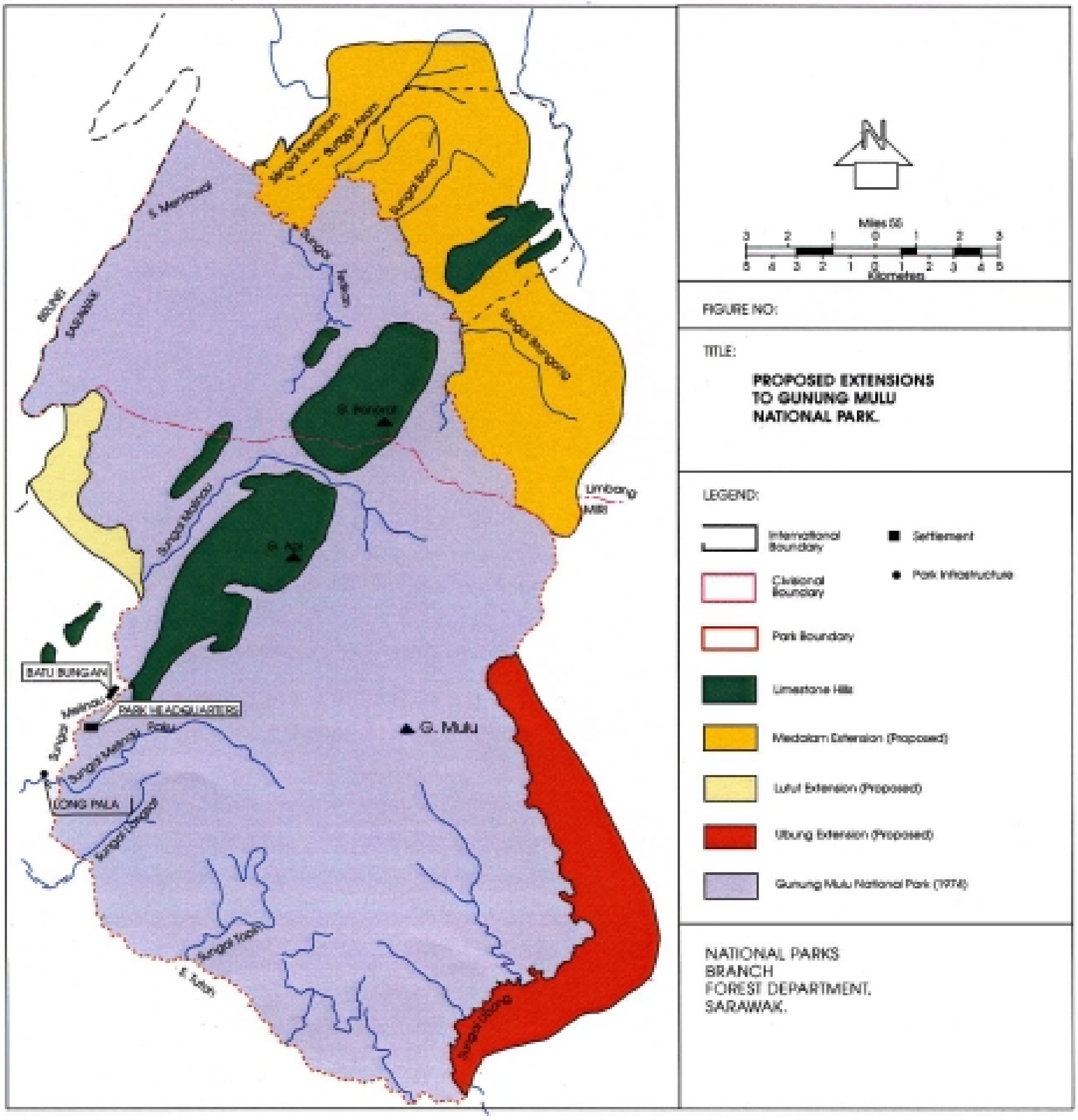
La lettre indique qu'un Plan intégré de développement et de gestion pour le PNGM est en cours de mise au point (achevé en octobre 2000). L'UICN a étudié ce plan qui accorde une haute priorité aux problèmes de capacité de gestion et aborde la question des avantages pour la communauté locale et des activités extérieures au parc.

L'UICN considère que la réponse dus autorités malaysiennes et le nouveau plan de gestion répondent de manière très satisfaisante aux inquiétude du Bureau concernant l'intégrité. Le PNGM pourrait donc être inscrit comme replissant les quatre critères naturels.

Le Comité souhaitera peut-être féliciter l'Etat partie de la préparation du Plan intégré de développement et de gestion ainsi que pour les progrès accomplis dans l'approbation des extensions au parc. Le Comité pourra aussi souhaiter inviter l'Etat partie à envisager le potentiel des extensions récemment classées comme compléments à la zone inscrite au patrimoine mondial.

National parks and wildlife sanctuaries of Sarawak. Wallace's line (inset)

Carte 1: Localisation – Parc national du Gunung Mulu



Carte 2: Carte du site – Parc national du Gunung Mulu